Research Application Summary

Participatory development, testing and validation of concepts and technologies for site-specific detection and control of plant parasitic nematodes infecting tomatoes in Mwea, Kenya

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Abstract

Tomato production in Kenya has been a lucrative business for smallholder farmers who cannot afford huge capital to invest in other cash crops. It is a major source of household incomes and has created employment that has resulted in improved livelihoods. Tomato production is hampered by, among other factors, pests and diseases. Plant parasitic nematodes, particularly root-knot nematodes are a serious pest problem in smallholder tomato farms in Kenya, yet the problem goes unnoticed by majority of farmers as they appear to be unaware of nematodes. Reduction of crop losses due to nematodes is one way of increasing crop yields. This project seeks to; create awareness of the damage caused by nematodes on crops and the economic implications; assess the spatial and temporal distribution of root-knot nematodes in both rain-fed and irrigated tomato fields in Mwea area; define and quantify the significant edaphic factors that regulate the spatial and temporal population dynamics of nematodes in tomato fields and in particular develop, test and validate methods to identify areas in tomato fields that are prone to nematode infestations by correlating the soil factors to the distribution and population densities of root-knot nematodes; create nematode-density-distribution maps for individual fields/soil types which will be superimposed on the physical survey map of the farms; and to validate and develop precision farming technology by carrying out greenhouse and on-farm trials on the nematode distribution map identified to be infested or prone to infestation by nematodes.

Key words: *Lycopersicon esculentum*, Root-knot nematodes, site-specific management

Résumé

La production de tomates au Kenya a été une activité lucrative pour les petits agriculteurs qui ne peuvent pas se procurer d'énormes capitaux à investir dans d'autres cultures

commerciales. Elle est une source majeure de revenus des ménages et a créé de l'emploi qui a abouti à améliorer leur subsistance. La production de tomates est entravée par, entre autres facteurs, les parasites et les maladies. Les nématodes phytoparasites, en particulier les nématodes à galles sont un problème grave de parasite ravageur dans les champs de tomates de petits agriculteurs au Kenya, mais le problème passe inaperçu à la majorité d'agriculteurs, car ils semblent ignorer les vers nématodes. La réduction des pertes de récolte dues aux nématodes est un moyen d'augmenter les rendements des cultures. Ce projet vise à faire prendre conscience des dommages causés par les nématodes sur les cultures et les implications économiques, à évaluer la distribution spatio-temporelle des nématodes à galles dans les champs à cultures pluviales et les champs de tomates irriguées de la région de Mwea, à définir et quantifier les facteurs édaphiques significatifs qui régissent la dynamique spatio-temporelle de la population de nématodes dans les champs de tomates, et en particulier à développer, tester et valider des méthodes pour identifier les régions dont les champs de tomates sont sujettes à des infestations de nématodes en corrélant les facteurs du sol à la distribution et aux densités de population des nématodes à galles, à créer des cartes de distribution de densité des nématodes pour les champs individuels/ types de sols qui se superposeront sur la carte d'étude physique des fermes et à valider et développer des techniques agricoles de précision en effectuant des essais dans la serre et à la ferme sur la carte de répartition des tomates identifiées pour être infestées ou susceptibles d'être infestées par des nématodes.

Mots clés: *Lycopersicon esculentum*, nématodes à galles, gestion des sites spécifiques

Background

Tomato (*Lycopersicon esculentum* Mill.) is financially an important crop for smallholder growers and a major source of livelihood for a majority of residents of Mwea, Kenya. A central issue in tomato production in Mwea is the reduction of yield and abandonment of land for intensive tomato production due to infestation by root-knot nematodes (RKN) (*Meloidogyne* spp.). In Mwea, only 2.5% of the tomato growers recognize nematodes as a production constraint (Oruko and Ndun'gu, 2001) with the rest attributing above-ground symptoms to other biotic or abiotic constraints. This lack of recognition of nematodes often results in wrong diagnosis and therefore inappropriate use of pesticides which has been without success. In order to

transform tomato farming into a commercially viable economic activity that enhances food security, increases household incomes and creates employment, there is need to increase both the area under tomato production and crop yields through efficient production and mitigation of crop loses. This necessitates the development of rapid, low cost and easy to implement site-specific RKNs management technologies. This study will carry out participatory research to develop, test and validate this technology in partnership with stakeholders in the tomato industry. By participating in the project, farmers will learn precision RKN control technology and also provide valuable input to make the technology effective and sustainable.

Literature Summary

Tomato is mainly grown by smallholder farmers in most of the arable areas in Kenya. The main production areas in Central Province are Kirinyaga (Mwea), Nyeri, Kiambu and Maragwa. In 2004, an estimated 75,101 tonnes of tomato valued at over KES. 1 billion were produced in the province (KARI, 2005). Root-knot nematodes (RKNs) are the most devastating pathogens and cause considerable yield losses in Kenya. Tomato plants infected by RKNs are more easily infected by other soil-borne diseases. This underscores the need for efforts to forestall the deleterious effects of nematodes on tomatoes.

Management of RKNs is required for profitable tomato production (Kariuki *et al*., 2006). In Kenya, the use of nematicides, biological controls, cultural practices and pest-resistant varieties to reduce crop loses have been used on a small-scale and often irregularly due to low level of nematodes awareness (Kimenju *et al.,* 2008). Chemical control practices have aroused concern amongst farmers and consumers because of their possible undesirable effects on environment (Luciano, 2004). It is thus desirable that their use be minimized and their applications be site specific. Site-specific agriculture technology affords the potential to optimize pest management by varying pesticide or other inputs to better match within-field variation in pest density. Site-specific management of RKN is of interest because population densities vary spatially within fields (Donald *et al.,* 1999; Avendaño *et al., 2003*), and with variable management in response to RKN population density, tomato growers might increase the efficacy and reduce the costs of RKN management practices. The success of site-specific nematode management requires an accurate infestation map (Wyse-Pester *et al*., 2002) which can be developed by investigating the relationship between nematode density and soil attributes.

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Study Description

The study is participatory with farmers providing information about problematic soils. A relationship between soil factors and nematode distribution and densities will initially be determined by dividing the tomato fields into 100 by 100m geo-referenced grids and taking 200 soil samples from the grids. For each soil sample, nematodes will be assessed using sampling procedure adopted from Dropkin (1980). The distribution of nematodes in the tomato fields will be assessed using two types of hosts (spinach and tomato) sampling procedure (Stevenson and Wyman, 2003). Simultaneously within each grid, soil electrical conductivity (EC), soil texture, bulk density, nutrient content, organic matter and pH will be measured at two depths (30- and 45-cm). Thereafter, nematode sampling and soil characteristics assessment will be carried out within the geo-referenced grids at regular intervals of one month both during rainfed and irrigated cropping using above procedures. The coinertia analysis will be performed to identify the relationship between individual soil factors and density of individual nematode species. All of the data collected will be compiled in GIS software and CANOCO software will be used to run statistics on the output files. Principal component analysis (PCA) will be carried out on soil and nematode data to determine spatial distribution in the nematode community between different soil texture/soil types. A canonical analysis will be used to determine which variables explain the greatest amount of variability in root-knot nematodes. Nematode management zones, defined as field areas having similar nematode densities, will be developed by identifying soil features (elevation, pH, shallow EC, deep EC) that will be highly correlated with tomato RKN distributions. A GIS system will be used to plot digital nematode density-distribution map of infested areas that will be superimposed on the physical survey map of individual farms. Gendered groups of farmers with youth representation will be selected to participate in the project. The sites selected will also serve as the learning/training and demonstration points for farmers. Four nematode control methods will be tested and evaluated at selected farmers' fields. Crop performance and yield and nematode densities in the crops will be monitored both in irrigated and rainfed crop fields using both destructive and non destructive harvest methods.

Research Application

A digital map of nematode distribution of the area will be produced and distributed to farmers and a copy posted in the internet. The farmers will benefit by acquiring knowledge/ information on production constrains caused by RKN and their

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precision management, thereby saving on production costs and reducing environmental pollution.

Acknowledgement

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