Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda

Research Application Summary

Evaluation of *Metarhizium anisopliae* for integrated management of termites on maize and *Grevillea robusta* in Uganda and Kenya

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Abstract

Termites are a major constraint to subsistence agriculture, causing yield losses up to 100%. Recent studies have demonstrated the efficacy of the fungus, *Metarhizium anisopliae* for controlling termites, but little is yet known about sustainable application of this biocontrol agent. This study will assess the optimum application rates and timing of *M. anisopliae* to protect maize and *Grevillea robusta*, and its persistence in soil, effects on non-target arthropods, and compatibility in maize-legume intercrop. Findings of the study are expected to enhance development of sustainable termite management strategies for small holder farmers.

Key words: East Africa, entomopathogens, integrated pest management, subsistence agriculture, termite damage

Résumé

Les termites constituent un obstacle majeur à l'agriculture de subsistance, causant des pertes de rendement jusqu'à 100%. Des études récentes ont démontré l'efficacité du champignon *Metarhizium anisopliae* pour contrôler les termites, mais on est encore peu informé à propos de l'application durable de cet agent de lutte biologique. Cette étude permettra d'évaluer les taux et le temps d'application optimale de *M. anisopliae* pour protéger le maïs et *Grevillea robusta*, et sa persistance dans le sol, les effets sur les arthropodes non-cibles et la compatibilité de culture intercalaire de maïs et de légumineuses. Les résultats de l'étude sont attendus pour favoriser le développement de stratégies durables de lutte contre les termites pour les petits exploitants agricoles.

Mots clés: Afrique de l'Est, entomopathogènes, lutte intégrée contre les ravageurs, agriculture de subsistance, dégâts des termites

Background

Maize *(Zea mays* L.) is a staple crop for millions of people in Africa (ECAMAW, 2005), and *Grevillea robusta* Cunn. is a popular versatile component of small-holder agroforestry in Eastern Africa (Harwood, 1998). Losses caused to such staple crops and trees directly impinge on the livelihoods of, especially the rural poor. It is thus imperative that sustainable technologies are developed to mitigate their production constraints such as termite damage. Estimates of losses due to termites vary widely. In East Africa, severe losses (50-100%) due to termites have been reported on various crops and tree species (Sekamatte, 2001; Nyeko and Olubayo, 2005). The increased risks of drought recently predicted in Africa during the twenty first Century (ACDS, 2006) suggest increased losses due to termites since increased termite attack is often associated with prolonged dry spell (Logan *et al*., 1990).

Until recently, termite control has largely relied on broad-spectrum and persistent organochlorine insecticides, but there are serious limitations and increasing legal restrictions associated with the application and efficacy of these chemicals (Logan *et al*., 1990). African subsistence farmers use various traditional termite control methods, including queen removal, intercropping, crop rotation and use of plant extracts, but often with limited success (Sileshi *et al.*, 2009). For such small-scale farmers who cannot afford expensive chemicals, a safe alternative solution needs to be developed. Recent field experiments with *M. anisopliae* isolate ICIPE 30 on maize in Uganda and Kenya showed significant increase in maize yields (Sekamatte, 2001; Maniania *et al*., 2002). The use of *M. anisopliae* provides an opportunity for sustainable control of termites in agroecosystems. However, information pertaining to the optimum application rates, persistence and compatibility of the fungus with other termite control methods is lacking.

Literature Summary

Until recently there has been little work on microbial control of termites in Africa. One of the pioneering studies on microbial control of termites at ICIPE (International Centre for Insect Physiology and Ecology) indicated the effectiveness of *Metarhizium anisopliae*, strain ICIPE 30, for the control of termites in pastures, nursery trees and mounds in Kenya (ICIPE, 1997). The effectiveness of *M. anisopliae* to control termites in maize cropping system was for the first time demonstrated in Kenya and Uganda (Sekamatte 2001; Maniania *et al*., 2002). The fungus formulated as granules and applied as seed treatment resulted in reduction of plant lodging and subsequent increase

in maize yield comparable to that obtained with the chemical insecticide lindane. The mechanism by which *M. anisopliae* protects crops against termite damage may be twofold: direct killing as a result of contact with fungal conidia or avoidance as a result of repellent action of the spores (Langewald *et al*., 2003; Mburu *et al*., 2009).

There are several potential advantages in applying *M. anisopliae* for termite control. In the soil, factors that negatively affect the fungus survival such as high temperature, ultra violet radiation and lack of humidity are absent or buffered (Langewald *et al*., 2003). The high termite density in their nests and grooming behaviour of termites is thought to increase the chance of epizootics caused by such pathogens and some isolates of the fungus are highly host specific (Lomer *et al*., 2001). *Metarhizium anisopliae* has recently been developed for control of termites in buildings in the USA and Australia (Milner, 2000) and the fungus has a high potential for exploitation into commercial bioinsecticide in Africa. Its production is cheap and facile, and can be formulated in a variety of ways.

Study Description

This study will be conducted in eastern Uganda and western Kenya using a researcher-farmer collaborative approach. Selected farmers will provide the necessary land, labour and local information for field trials. In Uganda, on-farm experiments will be established to determine the optimal application rate of *M. anisopliae* to protect *G. robusta* against termites, and its persistence and effects on non-target arthropods. Similarly, on-farm experiments will be established in western Kenya to examine the application dosage of *M. anisopliae* to protect maize against termites, and its compatibility in maize-legume intercrops. Each experiment will be laid in a randomised complete block experimental design, with 6 selected farms considered as replicates. Findings of the study will be disseminated through farmer feedback meetings, conferences, seminars and scientific publications.

Research Application

This study is expected to generate information which can be used to increase the productivity of maize and *G. robusta* in subsistence agriculture through sustainable termite control.

Acknowledgement

This study is funded by RUFORUM.

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