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Research Application Summary

Optimum application rates for naturally occuring enthropathogenic fugus for termite management in maize fields

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Abstract

In Africa, maize yield losses of 50-100% have been reported to due termite attack. Previous studies have demonstrated efficacy of *Metarhizium anisopliae* for controlling termites, however there is limited information available on the application rate to control the fungus on maize. To establish a suitable fungal application rate for management of termites in maize fields, four application rates of *M. anisopliae* granules (40 kg/ha, 60 kg/ha, 80 kg/ha and 0kg/ha) were evaluated. Treatments were replicated three times in a randomised complete block design (RCBD). Head counts of lodged maize due to termite attack were recorded weekly and yields per plot were taken at harvest. Data was subjected to ANOVA and means were compared by Tukey's test ($p<0.05$) using Genstat software. *M. anisopliae* applications significantly reduced maize lodging and increased maize yield with the 60 kg/ha and 80 kg/ha rates giving the highest yields. The application of *M. anisopliae* protected maize against termite attack. However, it is important that the application rate of 60 kg/ha and 80 kg/ha be assessed in different agro-ecological zones to optimise suitable rates.

Key words: Bio pesticides, maize, *metarhizium anisopliae*, termites, yield

Résumé

En Afrique, les pertes de rendement du maïs de 50-100% ont été indiquées suite aux attaques de termites. Des études antérieures ont démontré l'efficacité de *Metarhizium anisopliae* pour contrôler les termites, mais il y a peu d'informations disponibles sur le taux d'application du champignon pour contrôler les termites sur le maïs. Pour établir un taux d'application fongique approprié pour la gestion des termites dans les champs de maïs, quatre taux d'application de granules de *M. anisopliae* (40 kg / ha, à 60 kg/ha, 80 kg / ha et 0 kg / ha) ont été évalués. Les traitements ont été répétés trois fois dans un dispositif de blocs aléatoires complets (BAC). Le nombre des pieds de maïs tombés en raison de l'attaque des termites était enregistré par semaine et les rendements par parcelle ont été pris lors de la récolte. Ces données ont été soumises à une analyse de variance et la comparaison des moyennes a été effectuée par le test de Tukey ($p <0,05$) en utilisant le logiciel Genstat. L'utilisation de *M. anisopliae* a réduit de façon significative

la chutte des pieds de maïs et le rendement du maïs a augmenté avec des taux de 60 kg/ha et 80 kg/ha donnant les meilleurs rendements. L'application de *M. anisopliae* a protégé le maïs contre les attaques des termites. Cependant, il est important que le taux de 60 kg/ha et 80 kg/ha soient évalués dans différentes zones agro-écologiques pour optimiser les taux appropriés.

Mot Clés: Bio pesticides, maïs, Metarhizium anisopliae, termites, rendement

Background Information

Maize (*Zea mays* L.) is a staple crop for millions of people in Africa (ECAMAW, 2005). Losses caused to such staple crops directly impinge on the livelihoods of many people especially the rural poor. Estimates of losses due to termites vary widely in Africa. In East Africa, severe losses (50-100%) due to termites have been reported on a maize plantation (Sekamatte, 2001; Nyeko and Olubayo, 2005). Most of the termite species attacking maize in tropical Africa belong to the subfamily Macrotermitinae of which Macrotermes, Microtermes and Odontotermes are the prominent genera (Sileshi *et al*., 2009). The increased risks of drought recently predicted in Africa during the 21st Century (ACDS, 2006) suggest increased losses due to termites since increased termite attack is often associated with prolonged dry spells (Logan *et al.*, 1990). Until the late 1980s, termite control largely relied on broadspectrum and persistent organochlorine insecticides However there are now serious limitations and increasing legal restrictions associated with the application and efficacy of these chemicals (Logan *et al*., 1990). Field studies 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 mechanism by which *M. anisopliae* protects maize against termite damage is 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). The use of *M. anisopliae* provides an opportunity for sustainable control of termites in agro-ecosystems. *M. anisopliae* production is cheap and facile, does not require high input technology and can be formulated and applied in a variety of ways. The low fungus toxicity to humans compared with chemical pesticides is an advantage. However, information pertaining to optimal application rates is lacking yet this is critical, especially in small hold farms. This study sought to evaluate different application rates of *M. anisopliae* granules for termite management in maize.

Study description

The study was conducted in two sites (Siaya Agricultural Training Centre (ATC) and farmer's field in Ligega location) in Siaya County, Kenya. The county lies between latitude 0° 26' to 0° 18' north, longitude 33° 58' east and 34° 33' west and an altitude of 1100 to 1400 meters above sea level. Mean annual temperature of 22.50C and mean annual precipitation of 1800-2000mm (Jaetzold and Schmidt, 2008). *M. anisopliae* Isolate ICIPE 30 inoculum was mass produced at ICIPE, Nairobi on rice granules. The field sites were prepared before the onset of long rains in March 2013 and short rains

in September 2014 with each plot measuring 3 by 3 meters. *M. anisopliae* formulated in granules was applied at the following rates; 80 kg/ha, 60 kg/ha and 40 kg/ha at maize planting. These treatments and a control (0 kg/ha) were replicated three times in a random complete block design (RCBD). These treatments rates were equivalent to approximately 3g, 2g, 1g and 0g per maize hill. Maize was planted at a spacing of 75cm by 25cm. The fungus was applied to maize hill and thoroughly mixed with soil before two maize seeds were sown per hill. Termite damage was assessed by recording the number of lodged plants per plot weekly until harvest. Causes of lodging were ascertained by lifting the plant and examining the root and stem for typical Macrotermes and Microtermes damage (Wood *et al.*, 1980; Umeh and Ivbijaro, 1997).

Results and Discussion

Application of *M. anisopliae* granules significantly decreased maize lodging and increased maize grain yield. These results compare well with previous studies by Maniania *et al*. (2002) who showed that application of *M. anisopliae* isolate ICIPE 30 at maize planting decreased maize lodging and increased maize yield. Furthermore, similar trials carried out in Uganda with the same isolate (ICIPE 30) against termites demonstrated a 70 % increase in maize yield, comparable to that obtained with the use of the chemical insecticide lindane (Sekamatte, 2001). According to this author a single-season application is sufficient to provide full protection for another three seasons in maize planted on the same plot. According to Hussain *et al.* (2011) application of M. anisopliae to sugarcane sets at planting protected the canes against termite infection/bud damage significantly compared to the untreated control. *M. anisopliae* acts as a twofold bio control agent, through contact and repellence (Rath, 2000; Langewald *et al.*, 2003; Ahmed *et al.,* 2009; Mburu *et al.*, 2009). By contact *M. anisopliae* inoculum directly attaches to the termite exoskeleton and initiate pathogenesis resulting in termite mortality (Rath, 2000; Langewald *et al.,* 2003). By repellence; Mburu *et al.* (2009) showed that *Macrotermes michaelseni* detects the presence of *M. anisopliae* through olfaction at a distance and thus avoids direct physical contact with the fungus. This inherent potential to detect specific sickening signatures from potentially infective fungi and avoid it is therefore exploited as means to repel termite from crop. Application of 60k/ha and 80kg/ha of *M. anisopliae* granules protected maize against termite attack and increased maize yield significantly. However, it is important to note the results obtained in this study represent on evaluation of fungus in the locations with similar weather conditions. Research has shown that climatic and edaphic factors affect efficacy and persistence of *M. anisopliae* inoculum in the soil (Inglis *et al.*, 2001; Ahmed *et al*., 2009; Scheepmaker and Butt, 2010). There is a need for further studies to be conducted using the higher doses (60 kg/ha and 80 kg/ha) of *M. anisopliae* granules in different agro ecological zones, in order to optmise application rates.

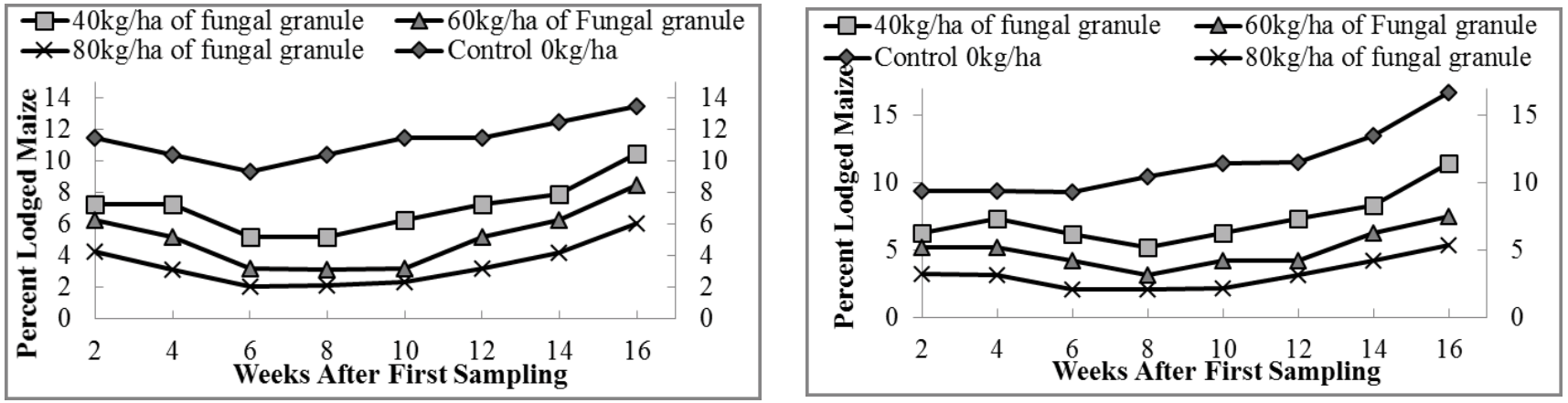

Figure I. Mean percentage of lodged maize plants over time during the long rain (a) and short rain (b) of 2013 trials following application of different rates of *M. anisopliae* granules against termite at Siaya ATC and Ligega

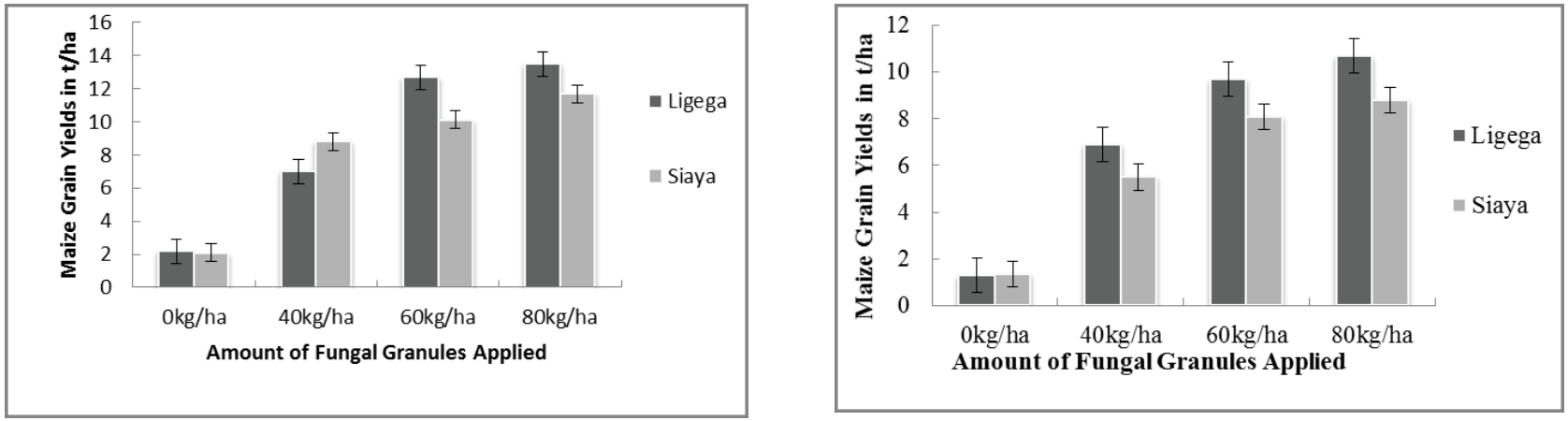

Figure II. Mean maize grain yields (±SE) for long rain (a) and short rain (b) of 2013 following application of different rates of *M. anisopliae* granules against termite at Siaya ATC and Ligega

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