Potential of entomopathogenic fungi as biopesticides of cassava *Bemisia tabaci* whitefly

Introduction

Cassava-colonizing whitefly *Bemisia tabaci* transmit viruses causing cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). These are the greatest causes of cassava production loss in Africa. Current systems of managing *B. tabaci* are only partially effective. CMD and CBSD management is based heavily on preventative, phytosanitary measures, with inadequate remedial treatments available to control outbreaks when they occur. Plant breeding for resistance to CMD has been successful but it is vulnerable to the evolution of resistance-breaking viral strains. There has been limited progress in developing varieties resistant to cassava brown streak viruses. Because the spread and severity of viruses is associated with abundant whitefly populations, management needs to include a control strategy for the whiteflies. Use of synthetic toxicant pesticides is increasingly restricted due to health and environmental concerns. Consequently, emphasis is being placed on control using other methods. The adoption trend is accelerating for the use of entomopathogens as a component of IPM strategies, and companies are marketing these to an increasingly wide range of agricultural crops. Despite increasing adoption, entomopathogens are yet to be tested for efficacy against cassava *B. tabaci* in Africa. *Bemisia tabaci* is susceptible to infection by a range of genera of entomopathogenic fungi. Several commercial products are available against *B. tabaci,* but these have not been investigated in detail on cassava-colonizing whiteflies. Entomopathogenic biopesticides effective against cassava-colonising *B. tabaci* will enable farmers to control this pest hence drastically reducing the impact of its transmitted viruses on cassava yield. These fungi are recognized as having minimal risk to people and the environment and are straightforward to use as opposed to synthetic insecticides.

Objective

To test the efficacy of commercial entomopathogenic biopesticides against cassava *Bemisia tabaci* whiteflies under laboratory and field conditions.

Methods

Laboratory experiment: Four commercial entomopathogenic biopesticides (Beauvitech = *Beauveria bassiana*, Lecatech = *Lecanicillium lecanii*, Met69 =

Metarhizium anisopliae and Mycotal = *Lecanicillium muscarium*) were selected for testing. Thirty adult whiteflies were confined to a single leaf using bread bags (third from the top, all other leaves were removed from the plants 24 hours before the experiment). Plants used were three weeks old and of the variety Albert. The whiteflies were removed after 72 hours and plants held in the screen house in cages until nymphs developed to the 2nd and 3rd instar stage nymphs. The biopesticides were sprayed on the nymph-bearing leaves using a 100 ml finger-tip sprayer at a rate of five times the concentration. The plants were covered with a misted polythene bag to maintain high humidity for 72 hours, after which the polythene bags were removed and plants covered with bread bags. The set up was with five plants per treatment with nymphs per plant in the range of 24 to 375 with an average of 172. Data were recorded at 5, 10 and 14 days for non-emerged, dead and emerged nymphs.

Field experiment: Two entomopathogenic biopesticides (Lecatech and Mycotal) were evaluated against cassava whitefly under field conditions. The experimental design was a randomized complete block design (RCBD) with three replicates. The cassava variety was Albert. Sixty cassava plants were planted in each of the three blocks that was divided into sub-plots of 20 plants each. The three sub-plots in each block were randomly allocated the Mycotal, Lecatech and control treatments. The biopesticides were sprayed twice at intervals of two weeks at a concentration rate twice the recommended. Ten plants from each sub-plot were randomly selected and tagged for monthly data collection. The data was recorded on a monthly basis for live adult whiteflies (top five leaves) and healthy and dead nymphs (6th to 10th leaf from the top).

Results

Laboratory experiment: At 5 days non-emerged healthy (85-98%) and emerged nymphs (0.3-3%) were not significantly different in the control (water) compared to the treatments. Numbers of dead nymphs were significantly higher ($P < 0.0001$) for Lecatech (7.6%) and Mycotal (8.8%) compared to the control and other treatments (Figure 1A). At 10 days – non-emerged healthy nymphs were significantly fewer ($P < 0.0001$) on Mycotal (9%) compared to the control (36%) and other treatments (31-39%) and dead nymphs were significantly higher ($P < 0.0001$).

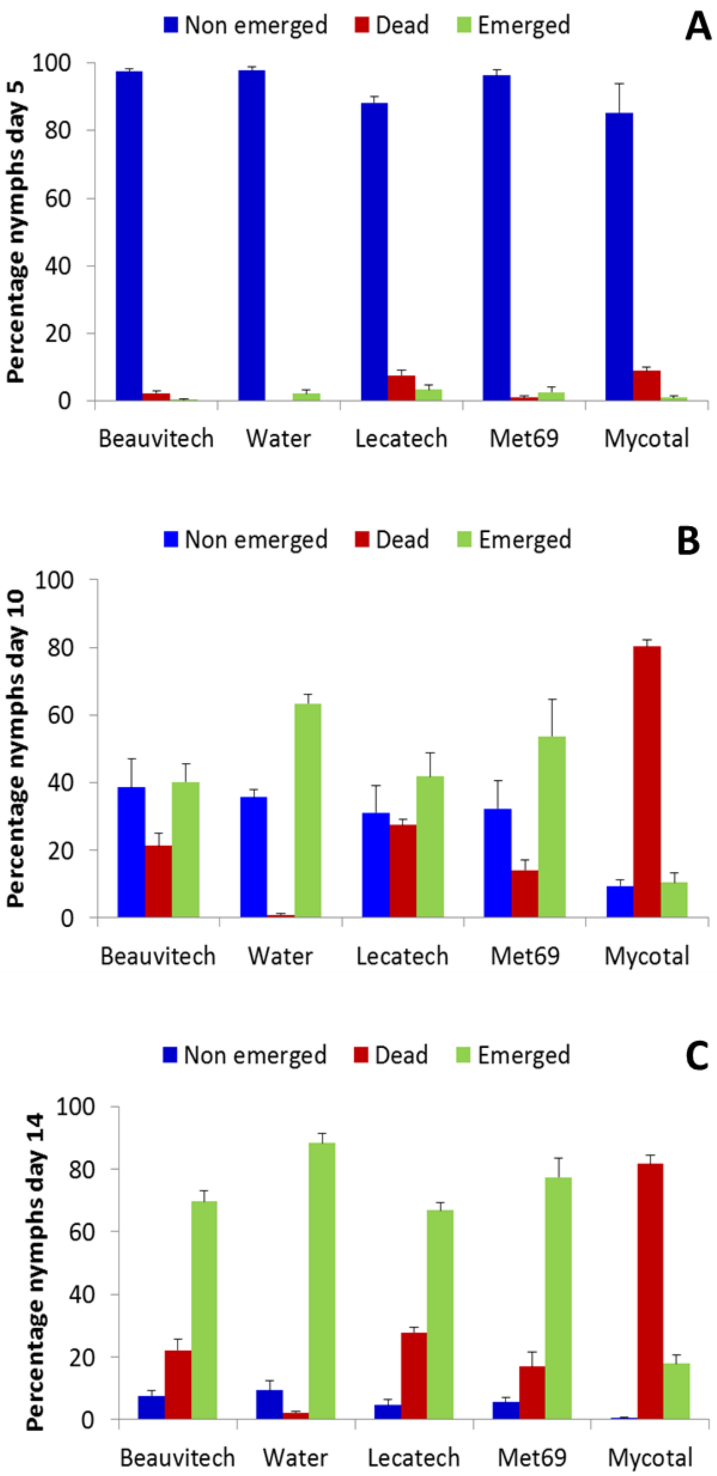

Figure 1: Percentage of cassava *Bemisia tabaci* non-emerged, dead and emerged nymphs at 5 days (A), 10 days (B) and 14 days (C).

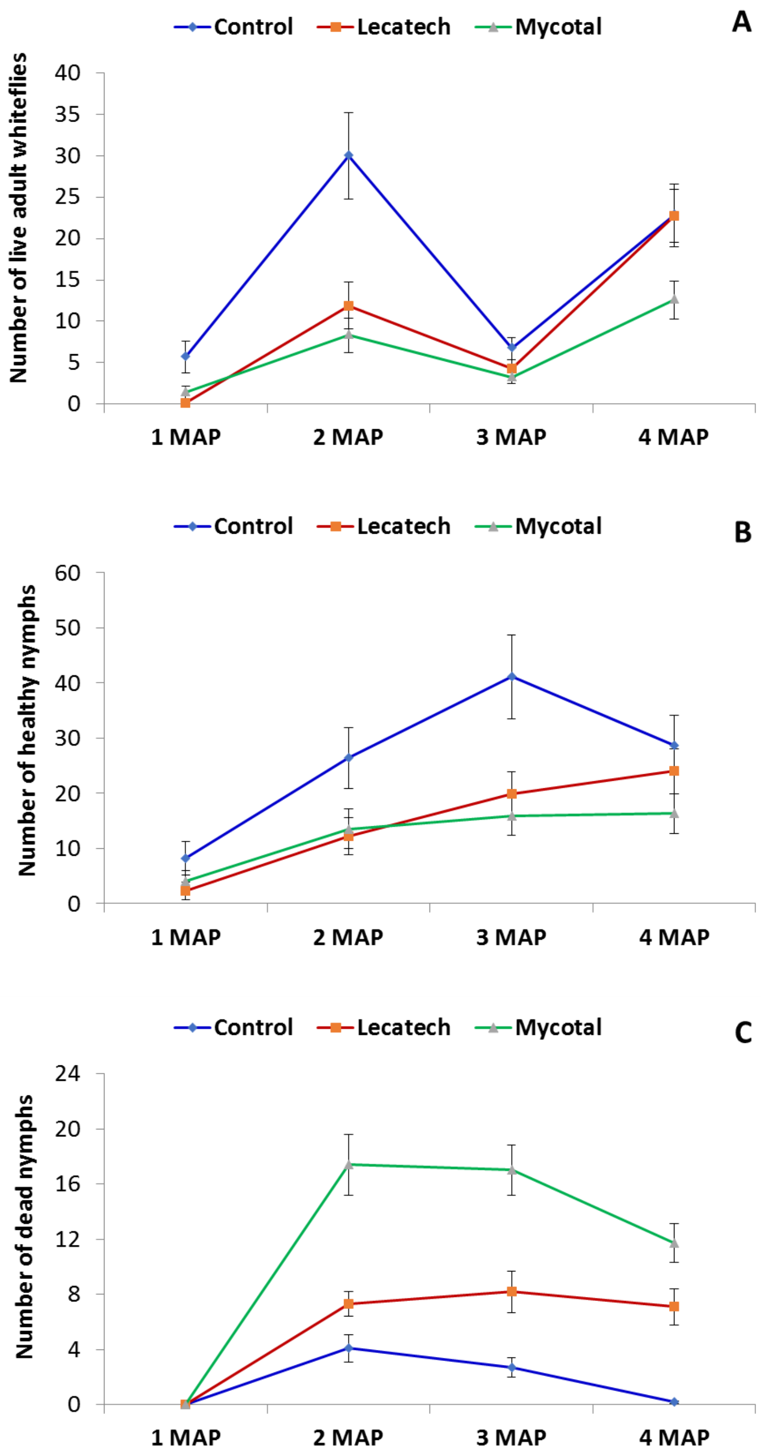

Figure 2: The number of live adults (A), healthy nymphs (B) and dead nymphs (C) of cassava *Bemisia tabaci* recorded at one-month intervals for four months.

0.0001) on Mycotal (80%) compared to the control (0.9%) and other treatments (14-27%). Emerged adults were significantly higher ($P < 0.0001$) in the control (63%) compared to the treatments (10-54%) with the fewest adults emerging with the Mycotal treatment (Figure 1B). At 14 days, non-emerged healthy nymphs were significantly fewer ($P = 0.0020$) on Mycotal (0.5%) compared to the control (9.4%) and other treatments (4.6-7.4%). Dead nymphs were significantly higher ($P < 0.0001$) on Mycotal (82%) compared to the control (2.2%) and other treatments (17-28%). Emerged nymphs were significantly more ($P < 0.0001$) in the control (88%) compared to Mycotal (18%) and other treatments (67-77%) (Figure 1C).

Field experiment: Mycotal had higher efficacy than Lecatech and both were significantly different from the control in most of the months. The numbers of live whiteflies (Figure 2A) and healthy nymphs (Figure 2B) were significantly fewer ($P < 0.0001$) by 1.7-4 times on Mycotal and 1-3.5 times on Lecatech compared to the control. Dead nymphs were significantly more ($P < 0.0001$) by 2.5-23 times on Mycotal, and 0.7-34 times on Lecatech compared to control plants (Figure 2C).

Discussion and Conclusion

Entomopathogenic biopesticides were tested against cassava *B. tabaci* under screen house and field conditions. The findings from this study reveal that Mycotal was the most effective against the whiteflies compared to the other biopesticides. This is a preliminary study and therefore further screen house and field experiments will be needed to ascertain the efficacy of Mycotal. These should be followed by farmer participatory trials and cost benefit anaylsis. Once proven effective and affordable, Mycotal will be recommended for incorporation into IPM packages for management of cassava whiteflies to mitigate the impact of whitefly transmitted viruses in cassava. Entomopathogenic fungi, if effective, are more preferred for control of pests compared to conventional insecticides that are harmful to non-target organisms and pollute the environment. The success of this in Africa will greatly improve management of pests as most farmers rarely afford expensive insecticides and those who do may lack proper equipment and skills hence leading to widespread contamination and in some cases poisoning. Incorporating entomopathogenic fungi into IPM will be a better option as opposed to insecticides as these are much less harmful to non-target insects.