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Research Application Summary

Entomopathogenicity of hyphomycete fungi to fruit fly *Bactrocera invadens* (Diptera Tephritidae) and their potential for biological control on mango

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Abstract

Suppression of fruit flies for increased mango production will increasingly rely on management methods which exert low negative environmental impact. Evaluation efficacy of three different baits contaminated with *M. anisopliae* to kill adult *B. invadens* was carried out. Percentage mortality of flies exposed to 10%- DuduLure (84%) was significantly higher than 2% NuLure (64%) at 21 days of exposure. This study developed cost-effective bait (DuduLure®) that when combined with *M. anisopliae* can significantly reduce populations of *B. invadens.* Growers' education will, however be fundamental for adoption of the application of *M. anisopliae* and food baits.

Key words: Baits, DuduLure, *Mangifera indica*, *Metarhizium anisopliae*

Résumé

La suppression des mouches de fruit pour la production accrue de mangues se fondera de plus en plus sur les méthodes de gestion qui exercent des impacts environnementaux négatifs faibles. L'efficacité de l'évaluation de trois appâts différents souillés avec l' *anisopliae* M pour tuer l'adulte *invadens* B ont été effectués. Le taux de mortalité des mouches exposées à 10% - DuduLure (84%) était sensiblement plus haut que 2% NuLure (64%) aprës 21 jours d'exposition. Cette étude a développé l'appât rentable (DuduLure®) qui, une fois combiné avec l' *anisopliae M* peut de manière significative réduire les populations de l' *Invadens B.* L'instruction des cultivateurs sera cependant fondamentale pour l'adoption de l'application de l'*anisopliae M* et les appâts de nourriture.

Mots clés: Appât, Dudulure, *Mangifera indica*, *Metarhizium anisopliae*

Background

The growth of the horticulture industry worldwide is greatly threatened by tephritid fruit fly infestation and Africa is the home of 915 fruit fly species from 148 genera including

Bactrocera invadens, a member of *B. dorsalis* complex which are polyphagus and ranked high in quarantine list (Drew and White, 2005). They attack both fruits and vegetables (USDA, 2008). Mango *Mangifera indica* L. is the most internationally traded fruit after pineapple in terms of volume and is the preferred host (Ekesi *et al.*, 2006). Mango trade is a vital part of horticulture in Kenya and earns an estimated value of US$ 14.7 million out of which fresh mango produce is estimatesd at 40% (HCDA, 2007). However, fruit fly damage to mango has increased to 80% since its discovery in 2003 resulting into high costs of production (Lux *et al.*, 2003). Small scale farmers own 90% of the industry. In Kenya, over 60 varieties and improved cultivars have been introduced in order to increase mango production but all suffer the damage by fruit flies.

Management of fruit flies is largely dependent on the use of food baits (hydrolyzed proteins) combined with chemical pesticide *malathion* and applied in localized spots which attract adult flies and kill them upon ingestion of bait. Weekly sprays of NuLure® bait is normally carried out to reduce fruit fly populations and reduce damage. Application of broad-spectrum pesticides is not encouraged as it may lead to elimination of beneficial non-targets, development of pest resistance, resurgence of secondary pests and environmental pollution. The integration of fungal entomopathogen and food baits in the management of the pest may result into quality mango fruits that meet the standards for both domestic and urban export markets without exposing the eco-system to the problems associated with pesticide use above.

Therefore the objective of the study was to assess compatibility, persistence and pathogenicity of *Metarhizium anisopliae* ICIPE 20 combined with three different food baits (NuLure®, local bait DuduLure® and 10% DuduLure (w/v)) exposed under mango canopy for suppression of laboratory reared adult *B. invadens*.

Literature Summary

Cultural methods of fruit fly management worldwide include orchard sanitation which involves incineration of fruit fly infested mangoes, bagging of fruit while still on trees and early harvest to evade fruit damage. Both methods have considerable consequences because *B. invadens* lays eggs on immature green mangoes and therefore renders physical methods inefficient (Clarke *et al*., 2005). Other management approaches include orchard sanitation, use of food baits, male annihilation,

sterile insect technique and post harvest treatment of produce. In Africa, most of these technologies have not been adopted by farmers due to lack of adequate knowledge and high cost of the technology.

The use of baiting in combination with entomopathogenic fungi in integrated pest management as an alternative to blanket pesticides spray offers environmentally benign tools which are target specific. The application can be relatively cheap in terms of product price, time and application equipment, but should not be used as a stand-alone method. There are currently over 40 fungal biological control agents (BCA) from division Eumycota, developed from 4 major sub-divisions and registered for use against various pests of medical and agricultural importance (Butt *et al.*, 2001). Recently several isolates of *Beauveria bassiana* Bals. and *M. anisopliae* (Sorok) Metsch (Deuteteromycotina: Hyphomycetes) have shown potential as biological control agents for management of *Ceratitis* group of fruit flies (Ekesi *et al.*, 2005).

Study Description

This research evaluated pathogenicity of 3 different food baits types contaminated with *M. anisopliae* isolate ICIPE 20 to *B. invadens* when exposed under mango canopy in the field for a period of 28 days. The field site for this study was located within ICIPE-Nairobi on a plot measuring one acre, planted with 12 mango trees of Carabao variety. The site is located at an altitude of 1600 meters above sea level, latitude S 01.22 and longitude E 36.90.

Data on weather under the mango canopy was recorded during the experimental period using a data logger (Hobo and Onset Computer Corporation, USA). The data logger was placed at a height of 1 meter above the ground under the mango canopy to record mean hourly temperature, relative humidity and daily precipitation of dew at the site throughout the experimental period.

The environmental impact on *M. anisopliae* contaminated baits on populations of adult *B. invadens* was evaluated in a completely randomized design experiment. Treatments consisted of 10% DuduLure, 2% NuLure and DuduLure® contaminated with conidia of *M. anisopliae* and , replicated 5 times. The experimental units was a replica of 10 flies receiving infection from each bait type, replicated 5 times with mortality as the variable and period of exposure as a factor. Impact of

environmental exposure on treated baits to *B. invadens* population over time was carried out using repeated measures on days 0, 7, 14, 21, 28. Controls consisted of baits without the fungus. The study run from May - June 2006.

Research Application

In the suppression study of *B. invadens* using 3 different baits, the resident time spent by flies on the baits ranged from 1 to 28 seconds, suggesting a considerable tolerance for fungus contaminated and aged bait stations (Ouna, 2010). Dilution did not affect attraction of fresh and old baits when exposed in the field. Germination of conidia that were spread on 2% NuLure® and 10% DuduLure baits remained high at 28 days of exposure in the field resulting into high percentage mortality of *B. invadens* on the 2 baits.

Percentage mortality of *B. invadens* in fresh baits and 7 days old baits was significantly higher in 10% DuduLure (98%) and 2% Nulure (100%) baits than in DuduLure®) (95%), however mortality was not significantly different between flies infected by 10% DuduLure and 2% Nulure ($P < 0.05$), respectively. After 14 and 21 days, significant differences in mortality was observed between two baits (10% DuduLure (95%)/ 2% Nulure (84%) baits) and DuduLure® (50%) bait ($P = 0.05$); 10% DuduLure (83.5%) and 2% NuLure (64.0%) DuduLure® (5.7%) ($P = 0.05$). Comparison of means using paired t-test after 28 days demonstrated that mortality was significantly higher in 2% NuLure than in 10% DuduLure® and measured 89.8% and 47.6% respectively ($P = 0.05$).

Table 1. Mortality of adult *B. invadens* infected in the laboratory with *M. anisopliae*-treated baits exposed in the field over time.

	Day 0	Day 7	Day 14	Day 21	Day 28
10% DL	97.8± 2.7 a	100 ± 0.0 a	95.6 ±2.7 a	83.5± 7.4 a	47.6± 12.6a
Nulure + Fungus	100.0± 0.0a	100 ± 0.0 a	84.0 ±16 a	64.0 ±5.8 a	89.8 ±4.25a
DL® + fungus	95.2 ±2.9 b	84 ± 6.4 b	50.0 ±7.0 b	5.7± 5.7 b	-

Column means of mortality (± SE) bearing the same letter are not significantly different by Student-Newman Keuls' (P=0.05). DL = DuduLure; 10%.

Recommendation

It is recommended that cheap locally available food baits 10% DuduLure laced with *M. anisopliae* ICIPE 20 can be used in fruit fly suppression in integrated pest management technology in combination with sanitation in mango growing areas where *B. invadens* exist. Because of the prolonged persistence of such stations, a repeated weekly application regime of the toxic bait is not required; instead, auto-inoculators can be serviced

only once after every 4 weeks, minimizing both cost of application and labour required in the deployment of the treatment. Growers' education will be fundamental for adoption of the application of *M. anisopliae* and food baits.

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References

Butt, T.M., Jackson, C. and Mangan, N. 2001. Introduction-fungal biological control agents: Progress, problems and potential. In: Fungi as biocontrol agents. T.M. Butt, C. Jackson and N. Magan (Eds.). pp. 1-8.

Clarke, A.R., Karen, F.A., Amy, E.C., John, R.M., Raghu S., George, K.R. and David, K.Y. 2005. Invasive phytophagous pest arising through a recent tropic evolutionary radiation: *Bactrocera dorsalis* complex of fruit flies. *Annual Review of Entomology* 50:293-319.

Drew, R.A.I., Tsuruta, K. and White I.M. 2005. A new species of pest (Diptera: Tephritidae:Dacinae) from Sri Lanka and Africa. *African Entomology* 13(1):149-154.

Ekesi, S., Nderitu, P.W. and Rwomushana, H.C. 2006. Field infestation, life history and demographic parameters of fruit fly *Bactrocera invadens* (Diptera: Tephritidae) in Africa. *Bulletin of Entomological Research* 96:379 – 386.

FAO IG –SG TF. 1999. Agricultural trade and food security: Agricultural factsheet. Third ministrerial conference. Rome, Italy, FAO.

HCDA. 2007. Progress report on Good Agricultural practices, MOA/HCDA/JICA-training team Horticultural crops Development Authority News.

Lux, S.A., Copeland, R.S. White, I.M., Manrakhan, A. and Billah, M.K. 2003. A new invasive fruitfly species from *Bactrocera dorsalis* (Hendel) group detected in East Africa. *Insect Science and its Application* 23(4):355-361.

USDA-APHIS. 2008. Federal import quarantine order for host materials for Bactrocera invadens (Diptera: Tephritidae) Invasive fruit fly species . USDA-APHIS. 3pp.