

Assessing the impact of integrated pest management programme for suppressing the invasive fruit fly (*Bactrocera invadens*) on mango in Mozambique

Cugala, D.¹, Jose, L.¹, Coccorrea, H.² & Ekesi, S.³

¹Faculty of Agronomy and Forest Engineering, EMU, PO Box 257, Maputo, Mozambique

²The International Centre of Insect Physiology and Ecology (*icipe*), Nairobi, Kenya

³Provincial Directorate of Agriculture, Pemba, Cabo Delgado, Mozambique

Corresponding author: dcugala@uem.mz; dcugala@gmail.com

Abstract

The invasive fruit fly, *Bactrocera invadens* (Diptera: Tephritidae) is a devastating quarantine pest that continues to threaten fruit and vegetable production in Mozambique. In Mozambique, since its first detection in the Northern region, no management measures have been implemented for it. The potential impact of IPM measures for the fly that are based on the use of baiting and male annihilation technique, use of fungal based biopesticide (*Metarhizium anisopliae*) and orchard sanitation with the Augmentorium were assessed. by The population density in the test plot (with IPM strategies) was much lower (93.5% population reduction) compared to that in control plots. The results suggest that *B. invadens* population can be effectively suppressed through a combination of management measures in mango orchards. It is recommended that the IPM strategy suggested in this study be exploited for a large scale use in Mozambique.

Key words: *Bactrocera invadens*, control, fruit flies, IPM

Résumé

La mouche invasive des fruits, *Bactrocera invadens* (Diptera: Tephritidae) est un insecte ravageur de quarantaine qui continue de menacer la production des fruits et des légumes au Mozambique. Au Mozambique, depuis sa première détection dans la région du Nord, aucune mesure de gestion n'a été mise en œuvre pour cela. L'impact potentiel des mesures de lutte intégrée contre la mouche qui sont basées sur l'utilisation des appâts et de la technique d'annihilation des mâles, l'utilisation de biopesticides à base de champignons (*Metarhizium anisopliae*) et de l'assainissement du verger avec l'augmentorium ont été évalués. La densité de la population dans la parcelle d'essai (avec les stratégies de lutte intégrée) était beaucoup plus faible (93,5% de réduction de la population) par rapport à celle dans les parcelles témoins. Les résultats suggèrent que la population de *Bactrocera invadens* peut être

effectivement supprimée grâce à une combinaison de mesures de gestion dans les vergers de manguiers. Il est recommandé que la stratégie de lutte intégrée suggérée dans cette étude soit exploitée pour une utilisation à grande échelle au Mozambique.

Mots clés: *Bactrocera invadens*, témoin, mouches des fruits, IPM

Background

The invasive fruit fly, *Bactrocera invadens* (Diptera: Tephritidae), was first detected in Mozambique in 2007 and now widely distributed in the northern part of the country. Its prevalence is low in the central region and absent in the southern part of the country as far the Save River (Cugala et al., 2011). Without its control, direct losses due *B. invadens* infestation is more than 80% (Ekesi and Billah, 2006). Additional losses in millions of dollars are associated with export restrictions of fresh fruits and vegetables to international and national markets. .

An integrated pest management approach that relies on a combination of techniques has been shown to effectively reduce the population of *B. invadens*, thus preventing its population expansion in Senegal, Benin and Kenya (Ndiaye et al., 2008; Vayssières et al. 2009; Ekesi et al., 2011). Despite the importance of *B. invadens* in Mozambique, there has been no attempt at managing the pest in the country. Currently, the use of orchard sanitation, protein bait, biological control and male trapping is being promoting in the Northern Province of Cabo Delgado to suppress *B. invadens* populations to acceptable levels of infestation and fruit damage. However, an assessment of the impact of this control methods in reducing *B. invadens* population and fruit damage is yet to be carried out. In this regard, the present study attempts to assess the impact of IPM strategies that is based on the use of orchard sanitation, protein bait spray, male annihilation technique, releases of the egg parasitoid (*Fopius arisanus*) and soil application of biopesticide in mango orchards in Mizeze, Pemba, Cabo Delgado Province.

Literature Summary

Fruit flies belonging to the family Tephritidae are considered a very destructive group of insects that cause enormous economic losses in fruits and vegetables (Vayssières et al., 2009). The fruit fly management strategies aim to reduce fruit flies population densities and consequently reduce crop yield losses (Ekesi and Billah, 2007). Fruit fly control requires a combination of management strategies. Management components such as the use of biological control (parasitoids and entomopathogenic

fungus, *Metarhizium anisopliae*), cultural control (orchard sanitation, use of augmentorium), baiting techniques (mazoferm, Nulure and Hym lure) and male annihilation technique (MAT) have been recommended for fruit fly suppression within an IPM context (Ekesi and Billah, 2007; Ndiaye *et al.*, 2008).

In Mozambique, there are no reports of any management approach for the suppression of *B. invadens* since its first detection in the country in 2007. In this regard, we implemented an IPM package (Orchard sanitation, use of augmentorium, entomopathogenic fungus, *Metarhizium anisopliae*, baiting technique (mazoferm and Nulure) in Mize, Northern Province of Cabo Delgado with the main objective of studying its effectiveness in suppressing *B. invadens* population density and reducing infestation of the pest on mango fruits.

Study Description

Field trials were conducted in Mize in the Northern Province of Cabo Delgado, where *B. invadens* is well established and widespread. Field work consisted of, 1) surveillance in farmers' fields to monitor pest population density; and 2) application of an IPM strategy that included orchard sanitation (use of augmentorium), soil application of entomopathogenic fungus, *Metarhizium anisopliae* and Nulure bait spraying.

Two sites were selected for the study: 1) Komoa-Koma (IPM sites) and 2) Niuji (control site). In the IPM test site, we applied orchard sanitation using the Augmentorium, soil inoculation with the entomopathogenic fungus, *Metarhizium anisopliae*, and conducted bait spraying using Nulure. The Augmentorium serves the double purpose of field sanitation and conservation of natural enemies of fruit flies (Klungness *et al.*, 2005). It is a tent-like structure that sequesters fruit flies that emerged from fallen rotten fruits that are collected from the field and deposited in the structure while at the same time conserving their natural enemies by allowing parasitoids to escape from the structure through a fine mesh at the top of the tent.

The fungal biopesticide was applied once at the rate of 1×10^{13} conidia ha^{-1} along the dripline of the mango canopy. The Nulure (7%) bait solution was applied weekly as spot application (50 ml) to approx. 1 m^2 of the canopy using a CP 15 knapsack sprayer. The second site was left without any control procedure (control plot). At each site, 4 Methyl Eugenol (ME) baited traps were installed to monitor *B. invadens* population densities on a weekly basis. All fruit fly specimens were counted and identified

to species level. *B. invadens* population density was estimated as the number of flies per trap per day (FTD). The potential impact of the IPM package used was assessed by comparing the *B. invadens* population density in treated field (IPM test site) and untreated site (control).

Research Application

The fluctuation of *B. invadens* population at both study places showed a similar pattern during the study period with a major peak occurring in March at the control site. The population density in the test site (with IPM strategies application) was much lower compared to that in the control site (Fig. 1). At the beginning of the trials, *B. invadens* population density was almost the same in both experimental sites at the beginning of mango season. However, as the season advanced, significant decline in population density was noted ($FTD < 1$) at the IPM test site while the population at the control site continued to increase ($FTD > 2$) (Fig. 1). Although no fruit infestation data were collected, observation of field collected adult *B. invadens* from the IPM plots showed mycosis due to *M. anisopliae*. This result proves that there is an impact of the IPM strategy used in the management of the fruit fly. The total captures of *B. invadens* during the study period from both places were 6,915 and 450 *B. invadens* individuals respectively in control and test sites, corresponding to a 93.5% population reduction.

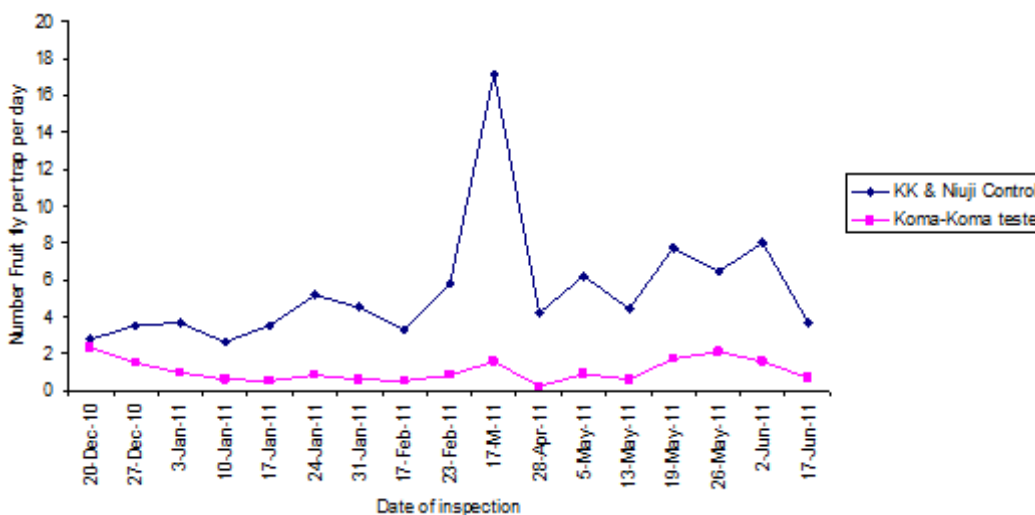


Figure 1. Mean numbers of *B. invadens* per trap per day (FTD) in treated and untreated plots during the period of study.

In Senegal, Ndiaye et al. (2008) achieved 83% *B. invadens* population reduction by implementing this IPM package on mango orchards. Ekesi et al. (2007) reported up to 79% reduction in *B. invadens* population through the use of the

protein bait, NuLure mixed with spinosad in combination with soil inoculation of *M. anisopliae*. Additional studies by Ekesi *et al.* (2011) showed that during the 2006/2007 mango season in Kenya, average post-treatment samples showed that *B. invadens* catches from the control orchards were four times higher than the number of flies captured in the plots that were treated with *M. anisopliae* and GF-120 spinosad bait spray. In the 2007/2008 mango season, average *B. invadens* post-treatment samples in the control mango orchards were seven times higher than the treatment with *M. anisopliae* and GF-120 spinosad bait spray. In Benin, Vayssières *et al.* (2009) reported significant suppression of native and exotic fruit flies by GF-120 spinosad bait spray.

The present results suggest that the invasive fruit fly, *B. invadens* population can be managed or suppressed locally at the growers' fields using the combination of available IPM components that includes, protein baits spraying, field sanitation, fungus soil application and male annihilation with methyl eugenol. Ndiaye *et al.* (2008) stated that the control concerning *B. invadens* must call for a whole set of complementary methods and that if used cooperatively at large scale may reduce fruit fly losses by 90% or more. Therefore, the present results indicate that the incorporation of a number of different fruit fly management techniques could be exploited on a large scale in space and in time for better results. Additional studies are exploring mass releases of the egg parasitoid in the same locality which should further impact on the exploding population of *B. invadens* in the areas affected by the pest.

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