

Research Application Summary

A comparative study of two sampling approaches for the coconut whitefly and its associated parasitoids in Inhambane province, Mozambique

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Abstract

Research to develop and evaluate pest management tactics requires meaningful measurements of populations of pests and/or beneficial organisms for accurate and precise estimation. Sample size and number of samples corresponding to fixed levels of precision varies with the population levels of interest. This means that a fixed sample size that provides adequately precise population estimates at low population level is unnecessarily large when the population levels are high. A study was conducted to compare two sampling approaches for coconut whitefly, *Aleurotrachelus atratus* (whitefly density) and the associated parasitoids (density and rate of parasitism) in Inhambane Province, Mozambique in order to guide future research in relation to field sampling approaches especially where resource constraints are important considerations. Two approaches were compared to assess their similarities and differences in terms of results based on whiteflies and their associated parasitoids in Inhambane province. Results from five districts of the province showed that whitefly density differed significantly between the two approaches/methods according to t-test at 95% confidence level ($P = 0.0000$). However, there was no significant difference between the two methods in terms of parasitoid density at 95% confidence level ($P = 0.0635$). Nonetheless, studies for comparison of insect sampling methods should include reduction of distance between sampling points and increasing the number of plants per sample (sample size) to increase precision.

Key words: Density, distance, parasitoids, pests, sampling

Résumé

La recherche visant à développer et évaluer les méthodes de lutte contre les parasites nécessite des mesures significatives des populations d'organismes nuisibles et / ou utiles pour une estimation précise. La taille et le nombre d'échantillons correspondant à des niveaux de précision fixes varient en fonction des niveaux d'intérêt de la population. Cela signifie qu'une taille d'échantillon fixe qui produit des estimations adéquates à niveau inférieur de la population est inutilement importante lorsque les niveaux de population sont élevés. Une étude a été menée pour comparer deux approches d'échantillonnage pour la mouche blanche de noix de coco, *Aleurotrachelus atratus* (densité de la mouche

blanche) et ses parasitoïdes associés (densité et taux de parasitisme) dans la province d'Inhamabane, au Mozambique, afin de guider les recherches futures en relation avec les approches d'échantillonnage sur le terrain, en particulier lorsque les contraintes pour les ressources deviennent importantes. Deux approches ont été comparées pour évaluer leurs similitudes et leurs différences en termes de résultats basés sur les mouches blanches et leurs parasitoïdes associés dans la province d'Inhamabane. Les résultats dans cinq districts de la province ont montré que la densité des mouches blanches différait considérablement entre les deux approches/méthodes. Cependant, il n'y avait pas de différence significative entre les deux méthodes en termes de densité de parasitoïdes. Néanmoins, les études comparant les méthodes d'échantillonnage des insectes devraient prendre en compte une réduction de la distance entre les points d'échantillonnage et augmentation du nombre de plantes par échantillon (taille de l'échantillon) pour augmenter la précision.

Mots clés: Densité, distance, parasitoïdes, parasites, échantillonnage

Introduction

Research to develop and evaluate pest management tactics typically requires meaningful measurements of populations of pests and/or beneficial arthropods (Spurgeon, 2007) which must be both sufficiently indicative of the true population parameters (accurate) and precise. This provides an acceptable degree of confidence in the estimates to permit unambiguous distinction of the effects of the studied factors (Spurgeon, 2007). Mathematical precision is usually improved by increasing the number of samples (Karandinos, 1976) collected. However, sample size and number of samples corresponding to fixed levels of precision varies with the population levels of interest. This means that a fixed sample size that provides adequately precise population estimates at low population level is unnecessarily large (and thus expensive) when the population levels are high. In addition, it is frequently impractical to collect enough samples to precisely estimate very low population levels. In most cases, sample sizes are dictated by the availability of resources (such as time or money), which are typically limited. Sampling methods intended to directly estimate population densities ('absolute' methods) tend to be laborious and expensive (Spurgeon, 2007). A study was conducted to compare two sampling approaches for coconut whitefly, *Aleurotrachelus atratus* (whitefly density) and the associated parasitoids (density and rate of parasitism) in Inhamabane Province, Mozambique in order to guide future research in relation to field sampling approaches especially where resource constraints (money and time) are important considerations.

Materials and methods

Description of the study area. Inhamabane province is located on the coast in the southern part of Mozambique with an area of 68,775 km² covered by 12 districts (EdM, 2013). It is bordered to the North by the Provinces of Manica and Sofala, to the South and East by the Indian Ocean, and to the West by the Province of Gaza. The climate is tropical throughout, more humid along the coast with a lot of mangrove swamps and dryer inland. Annual average temperature ranges between 19.5°C and 28.1°C with annual rainfall of 949.8

mm (WMO, 2015). The province is known for crop production, being the first in coconut production, second largest grower of cashew nuts (after Nampula), and also an important source of citrus fruits in the country.

Sampling locations. Two approaches were compared to assess their similarities and differences in terms of results based on whiteflies and their associated parasitoids in Inhambane province. Five (5) districts were sampled including; Zavala, Inharrime, Jangamo, Morrumbene and Massinga based on their coconut production potential.

In the first approach (method A), three (3) locations were purposefully selected and sampled in each district based on the availability of coconut fields with trees not taller than 3m high and accessibility of fields. Three (3) fields were sampled in each location selected using the snowball procedure. In the second approach (method B), the starting point was scored based on the presence of coconut trees under 3 m high and at least 50 m away from the main road to avoid the potential influence of wind from moving vehicles (Germano *et al.*, 2015; Keret *et al.*, 2015). From here, others were selected systematically after every 20 km distance along the main road, using the mileage of the vehicle.

Sampling procedure. In the first approach (method A), five plants were selected in each field purposefully (based on presence of whitefly nymphs or pupae) for collection of leaflets and the third leaf considered from the top for study. Three leaflets were cut from that (third) leaf considering the visual availability of whitefly pupae. The number of whitefly larvae collected on the leaflets was counted and recorded. A total of 365 plants (1,095 leaflets) were collected throughout the study under this method. In the second approach (method B), one plant was sampled per 20 km stop along the main road. Three leaflets were cut from the third leaf counted from the top and considering the visual availability of whitefly pupae on the leaflets. A total of 32 plants (96 leaflets) were collected throughout the study using this method.

After counting the pupae, the samples from each of the sampling methods were taken to the entomology laboratory at Eduardo Mondlane University, Mozambique and kept for at least 15 days after collection to allow for the emergence and death of both whiteflies and parasitoids. The samples were later opened and whiteflies individuals (adults, mummies and pupae) and emerged parasitoids were counted under an electric magnifying power.

Sampling was done between September 2015 and December 2015. Data were analyzed with STATA 12 and classical tests of hypotheses were done using 2-sample mean-comparison unpaired t-test at 95% confidence level.

Results

Whitefly density. Based on the results of whitefly density (Figure 1), the two approaches/methods differed significantly according to t-test at 95% confidence level ($P = 0.0000$). Mean whitefly density observed under method A (26.5 ± 1.22 pupae per leaflet) was less than of that observed under method B (59.5 ± 5.98 larvae per leaflet).

Parasitoids. Four parasitoid species were recovered from the whitefly pupae, which included; *Encarsia basicincta* Gahan (Hymenoptera, Aphelinidae), *Eretmocerus cocois* Delvare (Hymenoptera, Aphelinidae), *Encarsia* sp. and *Signiphora* sp. The overall rate of parasitism of the recovered parasitoids was $10.74 \pm 2.03\%$ with *Encarsia* sp. having the highest rate of $5.99 \pm 1.62\%$, followed by *Encarsia basicincta* ($4.08 \pm 0.94\%$), *Signiphora* sp. ($0.45 \pm 0.26\%$) and *Eretmocerus cocois* having the lowest rate of 0.22 ± 0.08 .

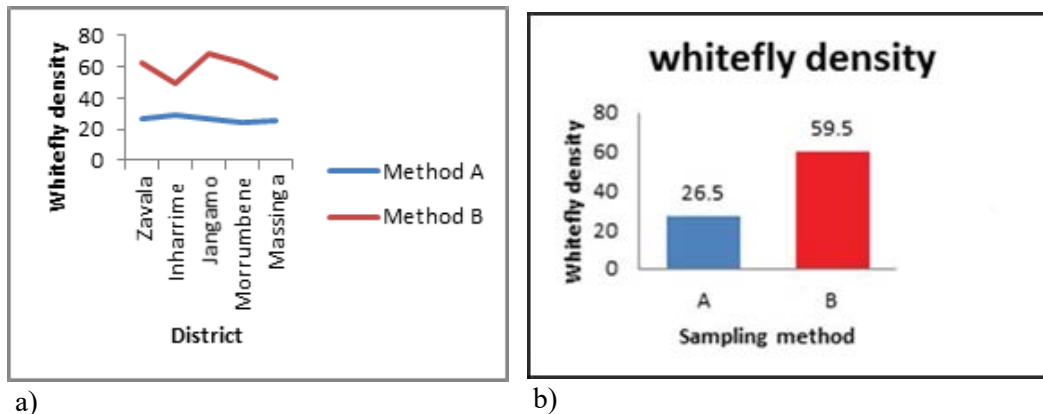


Figure 1. Variation in whitefly density under different sampling methods among districts

Parasitoid density. Results of the parasitoid density recorded from the two different approaches/methods are shown in Figure 2. There was no significant difference between the two methods in terms of parasitoid density at 95% confidence level ($P = 0.0635$). Nonetheless, a lower parasitoid density of 2.5 ± 0.51 parasitoids per leaflet was observed under method A compared to parasitoid density of 4.3 ± 0.84 parasitoids per leaflet observed under method B.

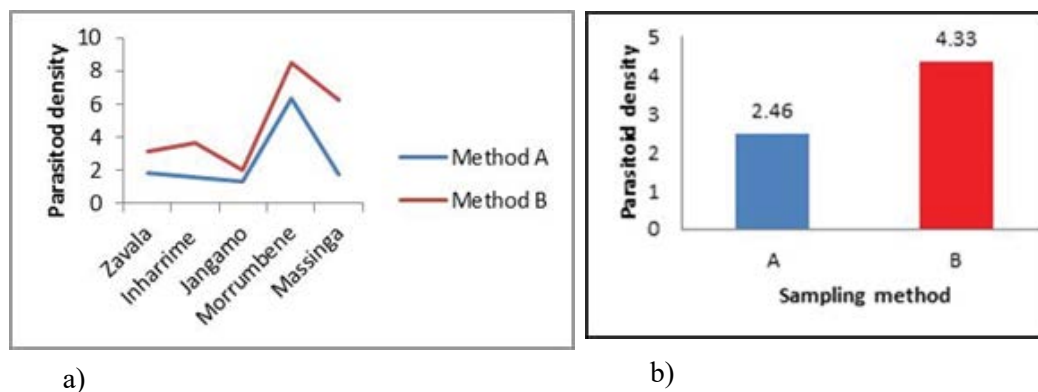


Figure 2. Variation in parasitoid density a) among districts under two different methods, b) according to method throughout the study.

Percentage parasitism. Based on percentage parasitism (Figure 3), there was no significant difference between the two methods based on t-test at 95% level of confidence ($P = 0.3060$). Percentage parasitism based on method A was only slightly higher at $10.74 \pm 2.03\%$

compared to $7.98 \pm 1.75\%$ parasitism observed under method sampling B.

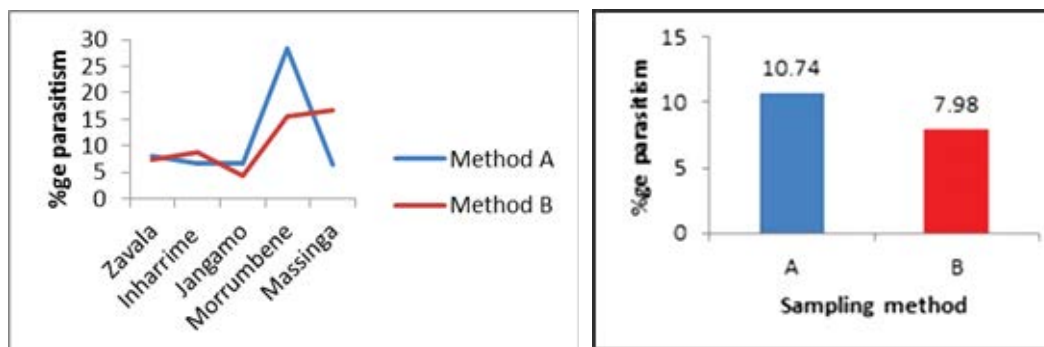


Figure 3. Variation in percentage parasitism among districts under two different assessment methods.

Discussion

Although a few of insect sampling methods have been compared with more ‘absolute’ methods to determine whether they accurately indicate population trends, any single method is typically inadequate for at least some of the species or stages sampled (Spurgeon, 2007). Thus, the sampling problem is compounded in studies in which more than one pest, or pests combined with complexes of beneficial arthropods, must be sampled. In these situations, sample sizes may be limited because resources must be partitioned among multiple sampling methods.

Limitations of sampling methodology are particularly relevant to efforts for refining economic thresholds, which are based on expected reduction in crop yield or quality in response to pest activity (Horn, 1988). Sampling is also problematic in treatment decision making because producers and crop consultants are more sensitive to sampling costs than are researchers. The practical realities of conducting research such as time, access to samples, and financial costs restrict the size of samples for most researchers (Carmen *et al.*, 2007). According to Cullen *et al.* (2000), university-recommended sampling schemes are often too expensive for commercial uses and expectations for precise pest population estimates in minimal sampling times is unfeasible. An under-sized study can be a waste of resources for not having the capability to produce useful results, while an over-sized one uses more resources than are necessary (Russell, 2001). Therefore, although larger sample sizes increase power and decrease estimation error, there is need to create a balance in generating a sample large enough to provide sufficient power but at the same time allowing for the ability to actually garner the sample (Carmen *et al.*, 2007).

Nevertheless, large distances between sampling points along the road and very low sample sizes may lessen precision levels significantly. Reducing distance between sampling points and slightly increasing sample size may help increase precision.

Conclusion and recommendations

Sample-size problems are context-dependent, for example, how important it is to increase the sample size to account for any uncertainty depends on practical and ethical criteria. Moreover, sample size is only one aspect of the quality of a study design, subjects and the aspects being studied. Nonetheless, insect sampling should include reduction of distances between sampling points and increasing the number of individuals per sample (sample size). This would increase precision within the limits of resources (money and time). More of such studies should be conducted to verify the consistency of the results of the sampling methods in Inhambane and other coconut growing areas of the country where coconut whiteflies are important pests.

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