Spatial and Probability Distribution of *Aphis gossypii* Infestation in West Africa: Application to Non Random Field Sampling

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ABSTRACT

A non-random sampling plan is proposed for monitoring insect infestation in cotton to facilitate spraying, based on action thresholds, to control Aphis gossypii on cotton plants in Central Africa. Non random sampling is preferred to random sampling because it is easier to implement. It is validated by the spatial distribution of the insect. This was studied with variograms and the probability distribution calculated by numerical integration.

Introduction

The aphid *Aphis gossypii* (Glover) (Hemiptera: Aphididae) causes increasing financial losses in cotton growing (Leclant and Deguine, 1994). Appropriate scouting techniques to enable aphid populations to be maintained below an economically acceptable level, require the development of sampling designs. Two designs are proposed. The first is fixed and for the estimation of infestation in a field. The second is sequential and is for decision-making by comparison with a threshold. Classic sampling methods generally assume independence between observations and obtain this by a random choice of individuals (Cochran, 1977). In practice, random selection is rarely performed in the field as implementation is difficult and requires numerous shifts of the observer's position. We first show that the spatial distribution of the insect makes it possible to propose valid systematic sampling. We then calculate the accuracy of the infestation estimator and design a sequential likelihood ratio test (Wald, 1947).

Methods

Insects were assessed on a pair of plants sharing the same sowing hole, as is usually the case in West Africa, taken as a ‘plant’ in what follows. Infestation of a plant was measured by number of infested leaves among the five terminal leaves. In a half-hectare farmer’s field in Bitanda (Chad), infestation was recorded on every plant once a week for 19 weeks. It was also recorded on 762 diagonal samples of 25 plants in farmers’ fields in Cameroon.

Variograms (Journel and Huijbregts, 1978) calculated for exhaustive counts (Figure 1) show the independence between infestation of different rows but correlation between the infestations of neighbouring cotton plant pairs in the same row. As a result, a systematic sampling scheme, with at most one plant per sowing row, yields independent observations. This is the case for diagonal samples. The number of infested leaves per plant in the sample then follows a binomial distribution, whose parameter p varies randomly from one row to another. Sampling distribution is therefore a mixture of binomials. The same mixing distribution remains throughout the 19 exhaustive counts. 25-plant samples show that sampling distribution is over-dispersed by a constant factor, as compared to the binomial.

Results

A fixed sample can be chosen large enough for a normal approximation of the infestation estimator to be valid. Its accuracy was calculated using the mean-variance relationship. The exact probability distribution was needed to design Wald’s (1947) sequential tests (Leclant and Deguine, 1994), for which one hopes for a smaller sample; it was determined numerically. We deduced likelihood ratio charts to enable the user to design his own test procedure according to the thresholds and the risks that he chooses.

References

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Figure 1. Map of *Aphis gossypii* infestation in a half-hectare farmer's field in Batanda (Chad). Symbol surface is proportional to the number of infested leaves among five terminal leaves.