Bollworm Sampling for Action Thresholds in Sub Saharan Africa: Spatial and Probability Distribution

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ABSTRACT

A diagonal sampling plan is proposed for monitoring insect infestation in cotton to facilitate spraying, based on action thresholds, to control Helicoverpa armigera in sub-Saharan Africa. The spatial distribution of larvae was studied with variograms. The probability distribution was inferred from the relationship between mean and variance. The probability distribution parameters were obtained by maximum likelihood estimation.

Introduction

The American bollworm *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) is a major insect pest of cotton in West Africa (Vassal *et al.*, 1997). Sampling designs are needed to monitor infestation and to control populations on a threshold basis. Classic sampling plans require a random selection of observed plants. This is not easy to perform and systematic schemes are widely applied without a theoretical background (Zalucki, 1991). A valid systematic sampling design is proposed, based on the spatial and probability distribution of the larvae.

Methods

What is referred to as a 'plant' is actually a pair of plants sharing the same sowing hole, as is usually the case in West Africa. Every cotton plant in nine quarter-hectare plots in Farako-Ba (Burkina Faso) was scouted for bollworm larvae. The number of larvae were also recorded on 2,099 systematic diagonal samples of 80 or 100 plants in half-hectare, unsprayed plots at 31 locations in Cameroon.

The spatial distribution of larvae was mapped (Figure 1) and studied with variograms (Journel and Huijbregts, 1978). The probability distribution was inferred from the relationship between the mean and the variance; the probability distribution parameters were obtained by maximum likelihood estimation. A sequential likelihood ratio test (Wald, 1947) was calculated after Oakland (1950). As the test procedure was truncated to set the maximum number of observations at 25, simulation was used to determine the probability of spraying (1-OC function) and the average number of samples (ASN function). Precise confidence intervals were calculated since normal approximations are not applicable when the infestation is low.

Results

The variograms show a random distribution of infested plants, thus validating any systematic sampling. The mean-variance relationship agrees with that of a negative binomial distribution with common k. Estimated k values are not significantly different in Burkina Faso and Cameroon; the 95% confidence intervals are respectively [2.04,2.71] and [2.11,2.94]. A common value of 2.4 was retained.

Truncating the sampling procedure does modify the OC function: for reasonable thresholds, the risk of undue spraying is still high (30%). Further research is needed to enable decisions to be made on a statistically and practically acceptable sample, possibly by distributing the sample among neighbouring fields.

References

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Figure 1. Map pf the number of larvae per pair of plants: Farako-Ba (Burkino Faso