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Evaluation of sampling methods for *Megalurothrips sjostedti* (Trybom) (Thysanoptera: Thripidae) on cowpea

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Abstract

Five sampling methods were evaluated for efficiency in estimating field populations of *Megalurothrips sjostedti* (Trybom) on cowpeas in Nigeria. The methods (sticky traps, water traps, sweep netting, shaking plants and the collection of whole plant samples) were judged on the basis of low sample variance, low cost and fidelity to absolute population trends. Shaking plants and water traps were the best sampling techniques on the basis of sample variance and cost. Shaking plants also showed the closest correlation with absolute population trends and is therefore recommended for rapid estimation of field populations of thrips. The performance of the usual alcohol method of sampling *M. sjostedti* on cowpeas (collecting racemes and flowers in alcohol) was not comparable with those of shaking plants and water traps, but was considered important because it sampled the infested structures, eliminating more transient visitors which might also be sampled by shaking plants.

Introduction

In most of its geographical range, the cowpea, *Vigna unguiculata*, is attacked by a wide range of pest insects. In tropical Africa, the bean flower thrips, *Megalurothrips sjostedti* (Trybom), is a devastating pest of cowpeas, infesting the flower buds and flowers. The feeding damage to these structures results in their necrosis and/or abscission, giving yield losses which have been estimated at between 20 and 100% (Singh & Allen, 1980). Current efforts to control this and other cowpea pests have centred on formulating dependable integrated pest management (IPM) strategies, which depend on, among other things, suitable sampling methods (Kogan & Herzog, 1980).

At the International Institute of Tropical Agriculture (IITA), Nigeria, where the bulk of cowpea research is carried out, the usual method of sampling *M. sjostedti* populations has been to harvest racemes and/or flowers in vials containing 30–50% alcohol. This method is time-consuming and may also adversely affect the plant. Notwithstanding this, little effort has been made to explore other sampling methods. In preliminary work, Salifu

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(1982) evaluated five sampling methods using sample variability as a criterion for selecting the appropriate method. However, the adoption of a particular method must not be based only on sample variance, but must also take account of sampling cost. Furthermore, an appropriate method should also show fidelity to absolute population trends. The present study was therefore undertaken to confirm the preliminary results, taking account of the cost of sampling and the degree to which relative population estimates reflected absolute density.

Materials and methods

Five sampling methods were compared with populations on whole plants (absolute density estimates obtained by cutting and bagging complete plants): collecting racemes and flowers in alcohol, shaking plants, sticky and water traps, and sweep net. These methods were classified into two broad groups according to the populations they sampled: (a) aerial sampling, comprising sticky and water traps, and (b) vegetation sampling, comprising the alcohol method, shaking plants and the sweep net. Evaluation was carried out at Ibadan, Nigeria, in a 0·02-ha field planted with cowpea cv. VITA 7 at a spacing of 0·75 m between rows and 0·25 m between plants within rows, thinned to one plant per hill ten days after planting (DAP).

Sampling commenced at raceme establishment (*ca.* 37 DAP) and was continued at five-day intervals for three weeks. All sampling methods were used on the same day, when ten samples were taken by each method.

Alcohol method

This method involved random collection of one raceme or flower per plant, according to the growth stage of the cowpea crop. Each raceme or flower was located by selecting a random number representing a point on each of two adjacent field margins, and the raceme or flower at this point was then pinched into a glass vial containing 30% alcohol. The process was repeated using the last point as reference until ten samples had been collected. The samples were dissected in the laboratory, washed in excess alcohol in gridded plastic petri dishes and all thrips counted under a macroprojector.

Shaking plants

Boards 41 cm long and 30 cm broad were constructed from 0·5-cm-thick sheets of plywood. One side of each board was painted with white gloss and divided into six grids of 100 cm^2 to facilitate thrips counting. At each sampling, transparent polyethylene sheets of similar dimensions as the boards, and covered with slightly diluted Tree Tangle Foot adhesive were pinned over the grid. The board was placed beneath each plant (selected randomly as for the alcohol procedure above), ensuring that the foliage was kept off the sticky surface. Each plant was tapped five times over the board, and all thrips dislodged from the plant were trapped by the sticky surface and counted *in situ*.

Sticky traps

Sticky traps were made from 20 × 3-cm glass boiling tubes, smeared on the exterior with Tree Tangle Foot and placed in the field at canopy level on upright wooden pegs and left for 9–10 h. Thrips were counted *in situ*.

Sweep net

A very fine nylon net with a subcircular diameter of 30 cm, tapering to 10 cm at the bottom, was used. Ten sweeps were made per sample, along a defined route to avoid sweeping the same area twice. Catches were placed in paper-lined plastic containers, along with cotton wool soaked with ethyl acetate, for sorting and counting in the laboratory.

Water traps

Water traps were made from white rectangular laboratory pans with a surface area of approximately 522 cm^2. A few drops of detergent (Teepol) were added to cause thrips to sink, plus two drops of 40% formaldehyde to preserve them. Traps were mounted randomly in the field on tripod stands at canopy level. The traps were left for 9–10 h in the field, after which thrips were counted *in situ*.

Cut and bag—absolute density estimates

Ten whole plants were selected randomly as in the alcohol method. Each plant was cut at soil level and quickly placed in a zippered polyethylene bag, chilled in an ice box and then transported to the laboratory. Thrips were recovered by first pinching off racemes and open flowers into glass jars containing 30% alcohol. The remaining vegetative parts were cut up and rinsed in soapy water. Counts from the alcohol and soapy water were pooled to obtain the total number of thrips per plant for each of the ten samples.

Data analysis

The efficiency of each sampling method was judged on the basis of low sample variance, low cost and similarity to absolute population estimates. Sample variability was determined by computing the relative variation statistic (RV) (Pedigo *et al.*, 1972; Southwood, 1978) given by RV% = (s.e./$\bar{x}$) (100); where s.e. = standard error of the mean, $\bar{x}$. The cost of sampling (Cs) was calculated in man-hours required to collect and process a sample by each method. Times were recorded in the field and in the laboratory using a digital quartz stop clock. The net effect of sampling variability and cost was computed by the relative net precision statistic (RNP) (Pedigo *et al.*, 1972; Hillhouse & Pitre, 1974; Southwood, 1978) and is given by RNP = $100/[(\overline{RV})(Cs)]$, where Cs is the cost in man-hours of sampling and processing one sample and $\overline{RV}$ is the mean sampling variability. RNP is an index directly proportional to the precision returned per unit cost invested. Larger RNP values indicate greater precision for effort expended.

The nearness to which the relative density estimates reflected actual population trends was determined by correlation and regression analyses using the linear model

$$y = a + bx$$

where y = relative density estimate, x = absolute density estimate and a and b are regression constants.

Results and discussion

Despite differences in the mean populations sampled, all sampling methods reflected similar population trends, with a gradual population build-up from flower initiation, peaking at full bloom and then diminishing as pods began to form and the number of flowers fell, apparently coinciding with emigration of adult thrips to new habitats.

The efficiency of each sampling method in terms of sample variability is shown in Table I. According to Southwood (1978), a relative variation of 25% is satisfactory for extensive surveys, while 10% is adequate for intensive studies of population dynamics. Because the present sampling methods were intended to determine whether a population was economically significant or not, a relative variation of about 25% was regarded as satisfactory for selecting the desirable method.

Shaking plants and water traps were the least variable, with relative variation values much less than 25% and comparable to the absolute method (Table II). Sticky traps and sweep net catches (and to some extent the alcohol method) were more variable, producing relative variation values in excess of the variability criterion, indicating that larger sample sizes may be required for them to be of value. However, Davidson & Andrewartha (1948),

TABLE I. *Relative efficiency of different sampling methods for* Megalurothrips sjostedti *on cowpeas*

Sampling method	Age of cowpea (DAP) 39 $\bar{x}$ ± s.e.[a]	RV[b]	43 $\bar{x}$ ± s.e.[a]	RV[b]	47 $\bar{x}$ ± s.e.[a]	RV[b]	51 $\bar{x}$ ± s.e.[a]	RV[b]	55 $\bar{x}$ ± s.e.[a]	RV[b]
Absolute										
Cut-and-bag	66·8 ± 2·5	3·7	168·8 ± 20·9	12·4	242·1 ± 24·1	10·0	179·5 ± 10·9	6·1	89·7 ± 9·6	10·7
Relative										
Alcohol	1·8 ± 0·6	33·3	7·9 ± 1·7	21·5	18·3 ± 3·9	21·3	45·3 ± 11·8	26·1	14·0 ± 3·5	25·0
Shaking plants	24·2 ± 2·3	9·5	53·7 ± 5·2	9·7	127·9 ± 7·4	5·8	117·6 ± 8·3	7·1	43·5 ± 5·8	13·3
Sticky traps	2·7 ± 0·9	33·3	4·6 ± 1·1	23·9	10·2 ± 1·9	18·6	11·1 ± 3·0	27·0	9·2 ± 2·6	28·3
Sweep net	2·6 ± 0·8	30·8	19·6 ± 5·1	26·0	39·9 ± 9·0	22·6	26·8 ± 7·5	28·0	21·8 ± 7·6	34·9
Water traps	25·2 ± 2·5	9·9	78·8 ± 6·4	8·1	60·3 ± 5·7	9·5	166·9 ± 20·3	12·2	46·8 ± 6·6	14·1

[a] Mean number of thrips per sample from ten samples.
[b] RV% = (s.e./$\bar{x}$) (100).
DAP = Number of days after planting.
RV = Relative variation.

TABLE II. *Cost, mean relative variation and relative net precision of different methods of sampling* Megalurothrips sjostedti *on cowpeas*

Sampling method	Cs[a]	RV[b]	RNP[c]
Absolute			
Cut-and-bag	0·20	8·57	58·34
Relative			
Alcohol	0·11	25·44	35·70
Shaking plants	0·03	9·07	367·51
Sticky traps	0·02	26·2	190·62
Sweep net	0·07	28·44	50·23
Water traps	0·02	10·75	465·12

[a] Cs = Cost = Mean number of man-hours per sample.
[b] RV = mean relative variation = (s.e./$\bar{x}$) (100).
[c] RNP = relative net precision = 100/(RV × Cs).

when sampling *Thrips imaginis* Bagnall, observed a mean relative variation of about 12% using 20 flowers per sample. Increasing the number of flowers to 40 per sample gave a more accurate estimate but was too expensive to sort and count. Increased sample size may therefore not be economic.

Shaking plants, sticky and water traps were less expensive in the number of man-hours required to sample and process a sample (Cs in Table II). However, when the time of leaving sticky and water traps in the field is taken into account, shaking plants was the least expensive. As expected, whole plant samples were the most expensive to collect and process, while alcohol samples took about half this time. Field costs were generally similar for all methods, but laboratory processing costs were greater and accounted for the main differences between the field and laboratory methods. Shaking plants and water traps were the most precise methods on the basis of the relative net precision criterion, largely due to their lower sample variability and cost (Table II). Although the absolute method was not being evaluated *per se*, its greater efficiency in terms of sample variability was almost nullified by the higher cost involved in collecting and processing samples.

Shaking plants also showed the greatest correlation with absolute density estimates (Table III). For sample sizes ranging from 20 to 30, Hosny (1964) noted, with *T. tabaci* Lindeman, a similarity between estimates on cotton obtained by washing whole plants and those obtained by shaking plants over a cloth. In the present studies, only shaking plants and sweeping accounted for an adequate proportion of the observed variation in the regression analyses (shaking plants: $y = -13{\cdot}9 + 0{\cdot}6x$, $R^2 = 0{\cdot}8$; sweep netting: $y = -2{\cdot}7 + 0{\cdot}2x$, $R^2 = 0{\cdot}77$). The results of the other methods were therefore difficult to interpret due to their low predictive values (sticky traps: $y = 3{\cdot}2 + 0{\cdot}03x$, $R^2 = 0{\cdot}3$; water traps: $y = 22{\cdot}0 + 0{\cdot}4x$; $R^2 = 0{\cdot}2$ and alcohol sampling: $y = 1{\cdot}0 + 0{\cdot}1x$, $R^2 = 0{\cdot}2$).

There are two important elements in the selection of the best sampling method. These are reliability and economy. All selection criteria studied here indicated that shaking plants and perhaps water traps were the most desirable for sampling *M. sjostedti* populations. However, unlike shaking plants, water traps overestimated thrips populations, and they are not easily amenable to calibration; therefore, except in general faunal surveys and

TABLE III. *Correlation matrix of six methods of sampling* Megalurothrips sjostedti *on cowpeas*

	Cut-and-bag	Alcohol	Shaking plants	Sticky traps	Sweep net	Water traps
Cut-and-bag	1·000					
Alcohol	0·467	1·000				
Shaking plants	0·906	0·751	1·000			
Sticky traps	0·568	0·662	0·830	1·000		
Sweep net	0·879	0·527	0·878	0·875	1·000	
Water traps	0·468	0·924	0·638	0·386	0·387	1·000

population monitoring, they are probably less suitable for sampling *M. sjostedti*. Shaking plants is recommended for rapid estimation of field populations of this pest by plant breeders and/or entomologists because it gives the most significant correlation with absolute populations. Although the alcohol method was not economical, it is recommended for use by cowpea entomologists because it is the only method that actually samples the plant parts which most sensitively reflect population fluctuations and also because sample variability appears to be about equal to the variability criterion ($R\bar{V} = 25{\cdot}4$). This recommendation is based on a sample size of ten and could be improved with perhaps a twofold increase in sample size. In addition, the alcohol method is the only one that satisfactorily samples larvae of *M. sjostedti*, which are perhaps of even greater economic importance than the adults.

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