FORSPA Publication No. 30/2002

Pest Management in Tropical Forest Plantations

Proceedings of the IUFRO/FAO Workshop
25-29 May 1998, Chanthaburi, Thailand



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Forestry Research Support Programme for Asia and the Pacific (FORSPA)
Food and Agriculture Organization of the United Nations
Bangkok.

Evaluation of Leucaena Psyllid Population Monitoring Methodologies: Within Plant Population Estimation

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Abstract

A sampling study was carried out in a five-months old *Leucaena leucocephala* plantation in Nakhon Ratchasima province, Thailand in 1998-99, to find out the most effective and practicable technique for field monitoring the psyllid (*Heteropsylla cubana*) population within a single plant. Three sampling methods were used - (i) cutting the third terminal leaf of a shoot and counting all the stages of the insect present, (ii) cutting one-third portion (distal, middle or proximal) of the leaf selected as above and counting the insects, and (iii) collecting the insects from three terminal shoots of a plant by jarring them into a plastic bag and weighing. The results revealed that the terminal portion of the leaf was the most reliable representative unit for estimating the total population on the leaf, in comparison with the other portions. Among the different developmental stages, the nymphal population showed the most significant correlation with the total population. In the jarring technique, there was a highly significant correlation between the weight and the number of insects. Therefore an equation was developed for prediction of psyllid population from their weight. This method was most practical, reliable and consumed least time for monitoring the psyllid populations in the field.

Keywords: *Heteropsylla cubana*, Leucaena, pest population monitoring

Introduction

Outbreak of the leucaena psyllid, *Heteropsylla cubana* in Thailand had been very serious since 1986 through 1991. The disaster struck not only the multipurpose forest plantations of leucaena but also the livestock feed mill industries dependent on leucaena. The unexpected high price of feeds encouraged farmers to substitute other leaf feed and to demand urgent, non-chemical control procedure for the psyllid. This led to intensive research on leucaena psyllid, including studies on the ecology and life table (Winotai, 1989), biological control and predation efficiencies (Napompeth, 1988; Attajarusit and Nanta, 1990; Attajarusit, 1991), plant resistance (Yantasath *et al.*, 1987) and other aspects (Napompeth, 1989). It was internationally accepted that leucaena psyllid population work was very laborious and time consuming. The work of Stechman *et al.* (1987) on sampling techniques showed that a combination of proximal and central leaflets from two compound leaves during their stretching process gave a reliable estimate of the total population instead of the absolute count of insects on shoot which required about 12 h per shoot. However, the work was still laborious. The objective of the present study was to find the most appropriate practical field technique for monitoring the psyllid population within a single plant.

Materials and Methods

The study was carried out in a five-month old *Leucaena leucocephala* plantation (planted in July 1988) located in Amphoe Pakchong, Nakhon Ratchasima province. The experiment was conducted in Randomised Complete Block Design, with 4 replications in a total area of 6400 m^2. The rows were 20 m long with a spacing of 0.75 m between rows. Sampling was carried out twice - first in December 1988 and the second in February 1989. Three sampling methods described below were tested.

1. Absolute count on single compound leaf

In this method, all individuals of the different developmental stages of *H. cubana* on a single compound leaf were counted. The whole third compound leaf from the shoot tip (in the "stretching stage") was cut by a pair of sharp scissors, collected in a plastic bag and securely sealed by a rubber band. The cutting was carried out swiftly and precisely to prevent the adults from escaping. A cotton ball dabbed with 95% ether was put into the bag to kill the insects. All sample bags were put in an icebox. In the laboratory, the sample was transferred to a freezer for five minutes to kill the live individuals and then the number of eggs, nymphs and adults were counted. There were 14 samples per replicate making a total of 56 samples for the first survey and 12 samples per replicate making a total of 48 samples for the second survey. Thus a total of 104 samples were collected.

2. Sampling of leaf portions

In this method, the leaf (third from shoot tip, as above) was visually divided into three portions, viz. X1 (distal portion comprising leaf pinnae 1 to 3); X2 (middle portion comprising leaf pinnae 4 to 7) and X3 (proximal portion comprising leaf pinnae 8 to 12. The technique required very sharp scissors, cutting skill and speed to prevent the psyllids from moving from one portion to another. An interval of 15 min was given between each cutting, to allow the insects to settle after the disturbance, before the next portion of the same leaf was collected. A whole third compound leaf of the same plant was also collected and the insects were counted to serve as a check for the total count (X). The killing and counting methods were the same as in the absolute count. On each sampling date, four plants were sampled from each of the four plots, yielding 16 samples (64 sampling units).

3. Jarring

The purpose of this sampling method was to investigate the possibility of using insect weight to calibrate the insect numbers and thus to substitute the laborious visual count of the individuals employed in the above two methods. A regression model of insect weight against individual counts was the expected result. In this method, there was only one survey time (February 1989) and the experimental design was for t-test of weight against number of individuals. A random sample of 3-leaf terminal shoot portion (two unopened and one opened leaves) was enclosed in a plastic bag, held firmly and shaken vigorously ten times. After an interval of 15-20 min, a second terminal shoot of the same plant was selected and the psyllids were shaken in to the same plastic bag as above. The same procedure was repeated for a third terminal shoot. The plastic bag holding the psyllids from these three terminal shoot shakings of the same plant was counted as one sample. A cotton ball dabbed with 95% ether was put into the bag to kill the psyllids and the bag was sealed using a rubber band and put in an icebox. On arrival in the laboratory, all leaf debris, cotton wool and all dirt were meticulously

removed from each sample bag. The bag was weighed and the total weight of the insects in the sample was arrived at using the tared weight of the plastic bag. Absolute count of nymphs and adults were made under a stereomicroscope. Records were made from a total of 23 samples.

Results

Absolute count and cut leaf portion count

The total number of insects representing all developmental stages of *H. cubana* on the whole leaf was greater in February 1989 than in December1988 (Table 1). In order to find if there was any statistically significant correlation between the population count in the whole leaf (X) with the population count in each cut leaf portion (X1, X2, X3), the statistical correlations were calculated. As may be seen from the correlation values given in Table 1, there was a significant correlation between X1 and X as well as between X2 and X. However, there was no statistically significant correlation between X3 and X.

Table 1. *Heteropsylla cubana* population count on whole leucaena leaf compared with population counts on cut leaf portions

Observation time	Mean no. of all stages				Correlation
	Whole leaf (X)	Distal portion (X1)	Middle portion (X2)	Proximal portion (X3)	
December 1988	161	240	230	200	$X_1X = .62^*$ $X_2X = .52^*$ $X_3X = .37$
February 1989	596	249	234	95	$X_1X = .99^{**}$ $X_2X = .69^*$ $X_3X = .37$

One star indicates statistical significance at 5% error and two stars indicate significance at 1% error.

Similar correlations worked out separately for counts of eggs, nymphs and adults on each leaf portion with counts for the same stage on the whole leaf are shown in Table 2. Only the nymphal population showed a significant correlation with the count for total leaf, with the distal portion showing the strongest correlation, followed by the middle portion and the proximal portion showing no significant correlation.

Table 2. Comparison of the number of eggs, nymphs and adults of *Heteropsylla cubana* on different leaf portions with the number of the same stage in whole leaf

Developmental stage	Mean no. of insects[1]				Correlation
	Whole leaf (X)	Distal portion (X1)	Middle portion (X2)	Proximal portion (X3)	
Egg	102	83	101	71	$X_1X = .39$ $X_2X = .42$ $X_3X = .48$
Nymph	58	153	124	126	$X_1X = .66^{**}$ $X_2X = .59^{*}$ $X_3X = .36$
Adult	2	4	5	3	$X_1X = .41$ $X_2X = .53$ $X_3X = .24$

[1] Mean of 128 samples.
One star indicates statistical significance at 5% error and two stars indicate significance at 1% error.

Jarring

The number of insects obtained by jarring the leucaena shoots and the weight of the samples are shown in Table 3. The correlation coefficient (r) for the total count of individuals and the weight was .96, which was highly significant. Therefore, a regression equation for estimated number of insects in relation with the weight was calculated. The equation obtained was $\hat{Y} = 134.96 + 656.15\ \hat{X}$, where $\hat{Y}$ is the number of insects and $\hat{X}$ is weight in grams.

Table 3. Total number of nymphs and adults of *Heteropsylla cubana* in relation with weight, from jarring technique

Sample no.	No. of individuals	Weight (g)	Sample no.	No. of individuals	Weight (g)
1	246	0.22	13	700	0.72
2	663	0.57	14	66	0.13
3	2 046	2.74	15	196	0.14
4	431	0.42	16	757	0.63
5	1 475	1.93	17	393	0.41
6	948	1.26	18	607	0.54
7	167	0.85	19	572	0.74
8	1 879	2.93	20	555	0.65
9	1 174	1.41	21	924	1.24
10	343	0.26	22	602	0.50
11	286	0.27	23	327	0.24
12	73	0.04			
$\bar{X}$				672	0.82

Correlation coefficient (r) (between number of individuals and weight) = .96**.

Regression equation: $\hat{Y}$ (estimated number of individuals) = 134.96 + 656.15 $\hat{X}$ (weight in g)
t (a) = 2.90 ** t (b) = 15.86 **.

Discussion

Sampling of cut leaf portions showed that the total number of insects on both distal (leaf pinnae 1 to 3) and middle (leaf pinnae 4 to 7) cut portions of the sampled compound leaf was significantly correlated with the total population on the whole leaf on both the sampling dates. However, the distal portion was the best representative, with the highest level of correlation. Sampling the distal portion also consumed less time than sampling other portions or sampling from more than one compound leaf as recommended by Stechman *et al.* (1987). The proximal portion gave no relationship to the absolute count.

Analysis of the correlation with each developmental stage of the psyllid revealed that only the number of nymphal stage, not the number of eggs or adults, was significantly related to the total population on the whole leaf. For the nymphal stage itself, the distal portion had a stronger correlation than the middle portion. It could be concluded that the distal portion is a reliable representative for sampling.

The jarring method yielded a highly significant regression equation that could be used for prediction of the number of insects by weighing the sample. Since this technique was accurate and the most practicable under field conditions, consuming least time, this method is recommended for monitoring *H. cubana* population on leucaena plants.

Acknowledgements

The author would like to express her sincere thanks to the WINROCK International Institute for Agricultural Development for financial support to this study and to Dr B. Napompeth of NBCRC, Thailand for his cooperation and support.

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