Evaluation of a Leaf-turn Method for Sampling Whiteflies in Cotton

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Abstract

Plans for sampling sweetpotato whiteflies in cotton were evaluated within 8,000 acres of cotton within central Arizona. These plans were found to be a practical and efficient way to track whitefly populations. In general they should add about 8 minutes to a pest sampling regime. Neither time of day nor sampler experience were found to have a significant effect on the number of whiteflies counted. Therefore, this method provides a common currency for growers, PCAs and others to compare whitefly numbers among fields and through time.

Introduction

Monitoring, in the form of an efficient, accurate and practical sampling program is central to the judicious use of insecticides. A sampling plan for sweetpotato whitefly (Bemisia tabaci Genn. strain B = Bemisia argentifolii Bellows & Perring) adults was developed and widely disseminated in 1994 (Naranjo et al. 1994, Ellsworth et al. 1994). This plan entails the visual inspection of a total of 30 leaves from two sites per field using a 'leaf turn' technique. This technique requires the scout to approach the plant and locate the fifth main stem node below the terminal. Turning the leaf by the tip or petiole, the scout determines the presence or absence of at least three adult whiteflies on the underside of the leaf. If three or more whiteflies are present, the leaf is scored 'infested,' otherwise the leaf is considered 'uninfested'. A percentage of infested leaves is then calculated and compared to a table that matches this number with the average number of adults per leaf predicted for the field (table 1). This technique is outlined in a trifold extension publication (Ellsworth et al., 1994). With this information, scouts can readily track the progress of an infestation in a field and time insecticide applications using action thresholds.

Although these sampling plans were developed from field data taken from the Maricopa Agricultural Center (Naranjo et al. 1994), we wanted to evaluate the accuracy and practicality of this method for use in commercial fields. In particular, we wished to answer the following questions:

1) How accurate is the model in predicting the mean number of adult whiteflies per leaf in a field from the percentage of infested leaves?

2) How long does it take to sample a field?

3) How much variation is there among samplers? That is, will different samplers get the same results?

4) What is the effect of time of day on the number of whiteflies counted?

To answer these questions, we evaluated these plans within commercial cotton acreage in central Arizona.
Methods

Sampling plans were evaluated within the Laveen-Tolleson area as part of a community-wide IPM project. From May 23 to August 18, a total of 1220 samples were taken within 190 commercial cotton fields (8,000 acres). Counts of adult whiteflies were taken as outlined in Ellsworth et al. (1994) with the exception that the total number of whiteflies present on a leaf was recorded rather than scoring the leaf as 'infested' or 'uninfested' in order to determine the accuracy of our relationship between percent infested leaves and mean number of whiteflies per leaf. About half of the samples were counts of whiteflies on 100 leaves (25 from each of 4 quadrants within the field) to determine the adequacy of the sampling models developed in describing the spatial distribution of adult whitefly populations. The other half were counts of whiteflies on 30 leaves per field (15 from each of 2 quadrants) to establish the practicality of the sampling method. For each field sampled, samplers used stop watches to keep track of the amount of time spent 1) walking from the truck to the first sampled cotton plant, 2) sampling whiteflies within the field, and 3) walking back to the truck.

In addition to evaluating sampling accuracy and efficiency, additional tests were set up to determine the effect of sampler and time of day on resulting whitefly counts. To determine the effect of sampler, whitefly counts were taken by 14 different samplers within adjacent rows of a field on 12 different dates. In some of the sampler variation tests, two samplers walked their sampling loops within the same quadrant of the field. These samplers varied in their amount of experience in sampling whiteflies; some had two years experience and others had two hours. Time of day effects were measured by having the same scout sample a field multiple times over the course of a day. Ten different fields were sampled. Time of day sampled ranged from 6 a.m. to 6 p.m.; the actual range of times sampled varied for each field.

Results and Discussion

Overall, the percent infested leaves (percent of leaves sampled which had 3 or more whiteflies per leaf) was an accurate predictor of the mean number of whiteflies per leaf in a field. In general, this binomial sampling model over-predicted the mean number of adult whiteflies observed for densities greater than 2 per leaf (figure 1). As a result, recommendations were conservative, resulting in decisions to spray just before reaching the target threshold. For example, for a threshold of 5 adults per leaf, the binomial sampling method (counts of infested or uninfested leaves) provided the same decision as counting the total number of adult whiteflies on a leaf 1166 out of 1206 times (96%) (figure 1). In 35 cases, the binomial method called for spraying when densities were below threshold, and 5 times this method called for not spraying when densities were above threshold. It is interesting that 4 of these 5 underestimates occurred on a day followed by rain. Based on these results, it is unlikely that a sampler would improperly assess the number of whiteflies by using this binomial method.

On average, it took about 4.25 minutes to exit and enter a field twice and 8.5 minutes to sample 30 leaves within the field (figure 2). However, the times recorded were the time to count all whiteflies on a leaf, rather than counting a maximum of 3 whiteflies (infested leaf). We estimate that this sampling method will add about 8 minutes to a pest management scouting regime. The actual time spent sampling will depend on field condition, time since last irrigation, crop development and sampler experience. In this study the time to sample 30 leaves ranged from 2.25 minutes to 18.8 minutes. The longer sampling times occurred in fields where the plants were lodged due to hail storms.

Sampler variation was not significant (figure 3). Two samplers within the same area of a field usually got similar results for the mean number of whiteflies in the field. This result was not dependent on sampler's experience. This sampling method, therefore, provides a common currency for growers, PCAs and others to communicate whitefly densities, even when the samplers are different.

The time at which a field was sampled also failed to have a consistent effect on numbers of whiteflies counted. The mean number of whiteflies counted changed significantly with time in 4 out of 10 fields (figure 4). Twice the numbers increased and twice the numbers decreased. In one of these four cases, the change in whitefly counts with time may have been related to the small size of and/or the high whitefly densities in the field. This field was only
1.5 acres in size. Two samplers, walking through this field 7 times each might have disturbed the whitefly population, causing the insects to move off of the fifth main stem node leaf or out of the field. In addition, the whitefly populations were the highest of any of the fields sampled in the time of day study (mean at 6 a.m. = 21.5 whiteflies per leaf). It is possible that these high densities influenced whitefly distributions on the plants over time. In general, this sampling method should be adequate for sampling both in the morning and in the afternoon.

**Conclusions**

This sampling protocol is an efficient, practical way to track whitefly populations. Decisions made with this "shortcut" binomial technique agreed with those made by counting all whiteflies on a leaf 96% of the time. In addition, it has the advantage over subjective methods such as 'cloud-rating techniques' in that results can easily be compared among fields, even if two different samplers did the counting. The results of the time of day study suggest that this technique may be used both in the morning and in the afternoon. Furthermore, as no extra equipment is necessary, this method may be readily incorporated into existing cotton pest scouting and plant monitoring protocols.

**Acknowledgments**

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**References**


Table 1. Threshold conversion table for binomial sampling method. An infested leaf is a fifth main stem node leaf with 3 or more adults/leaf.

<table>
<thead>
<tr>
<th>Threshold (adults/leaf)</th>
<th>Infested Leaves</th>
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<tbody>
<tr>
<td>1</td>
<td>14%</td>
</tr>
<tr>
<td>2</td>
<td>28%</td>
</tr>
<tr>
<td>3</td>
<td>39%</td>
</tr>
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<td>4</td>
<td>49%</td>
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<td>5</td>
<td>57%</td>
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</tr>
<tr>
<td>9</td>
<td>79%</td>
</tr>
<tr>
<td>10</td>
<td>82%</td>
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Figure 1: Relationship of percentage leaves infested with three or more adult whiteflies and the mean number of whiteflies per leaf and the four decision zones created by an action threshold of 5 adults per leaf. Dots represent actual field counts; the line shows the predicted relationship from the binomial model.

Figure 2: Average time required to sample 30 leaves from two different quadrants of the field using the leaf turn method (N>1000).
Figure 3: Comparison of sampler pairs in the ability to find the same number of adult whiteflies per leaf. The line represents unity (slope=1) where each sampler finds the same number of whiteflies.

Figure 4: Relationship between the number of adult whiteflies per leaf and hour of day. Regression lines were not significantly different from a slope = 0 in six of the ten fields monitored. In two of the four remaining fields, the counts went up significantly as it got later (A). In the remaining two fields, the counts went down significantly as it got later in the day (B).