Comparison of Sample Methods and Sample Plans for Thrips in Cotton

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Introduction

Thrips are a serious early-season pest on cotton throughout much of the U.S. cotton belt, and have been demonstrated to cause a 21% average yield loss to irrigated cotton in the Texas High Plains. Currently, much of the cotton in the Texas High Plains is proactively protected from thrips damage by the use of in-furrow and seed-applied insecticides. However, where thrips are not perennial pests, preventative insecticide use may not be necessary and foliar curative actions may be more economical. Additionally, many growers are interested in eliminating preventive pesticide applications for thrips management at planting as a means of reducing early season production costs. Currently, thrips in Texas are sampled using a whole plant inspection method where all the thrips are counted (i.e. enumerative). This technique is time consuming, tedious, difficult and may lead to inaccurate results depending on the scout's experience. Enumerative sampling can also increase sampling effort relative to a binomial (presence/absence) sample plan. Thus, the efficiency of visual sampling was compared to a cup sampling method. Additionally, binomial sampling was compared to enumerative sampling for both sampling methods.

Objectives

1. Develop and compare enumerative and binomial sampling plans for estimating thrips densities in seedling cotton.
2. To evaluate two thrips sampling techniques (Visual & Cup).
3. To develop the most cost reliable sample plan and method for making thrips management decisions in seedling cotton.

Materials and Methods

This study took place in a number of commercial cotton fields located across far west Texas and the Texas High Plains. Western flower thrips were sampled in each cotton field that was left untreated by foliar and/or preventative insecticides. Individual plants were examined for thrips from crop emergence to the five true leaf stage. 50 sampling bouts per field were conducted for each sampling method. Each sampling bout consisted of three plants.

Two sample plans (enumerative and binomial) and two methods (visual and 16oz plastic cup) were evaluated (Figure 1). Individual plants were removed from the soil by gently grasping the cotton stem at the soil line and pulling straight up. Then, the cotton plant was either subjected to the visual or cup sample method. Visual inspection was accomplished using a sharpened pencil to pry apart folded or creased leaf tissue to expose hidden thrips. Adults and nymphs were then counted and recorded. The cup method was employed by inserting the cotton plant into the cup and shaking vigorously for several seconds to dislodge any thrips into the cup. Adult and nymph thrips dislodged into the cup were counted, recorded and discarded.

Figure 1. Visual sampling method (left) and cup sampling method (right).

Materials and Methods (continued)

Taylor's parameters were determined for thrips adult and nymph age classes and were pooled across age classes. Different age classes may have different spatial patterns, resulting in substantial differences in required sample number for estimating population densities. Sample data from both methods were used to determine the proportion of cotton leaves infested to mean thrips density (Wilson and Room 1983). The relationship of the mean and proportion of thrips infested cotton leaves was determined by:

$$P(I)=1-e^{-m[LN(amb-1)/(amb-1-1)]}$$

Where P(I)=the proportion of thrips infested leaves, a and b are parameters from Taylor's power law (1961) and m=the mean density at which a management decision is needed. Taylor's power law parameters were determined by iterative non-linear regression. Science based economic thresholds have not been established for thrips in cotton. Therefore, an empirically derived nominal threshold of 1 thrips per true cotton leaf was used in this study. The optimal sample size for estimating this threshold for enumerative and binomial sampling was determined using the following equations presented by Wilson et. al. (1983b).

Enumerative sampling: $n=t^2_\alpha * d^{-2} * amb^{-2}$; Binomial sampling: $n=t^2_\alpha * d^{-2} * q * p^{-1}$

Where n=sample size, t_α=standard normal variate, d=a fixed level of precision (defined as a proportion of the ratio of half the desired confidence interval to the mean). A and b are Taylor's coefficients, q=1-p and p=the proportion of thrips infested leaves.

A consideration of cost, expressed as time to collect the sample, is especially important in selecting sampling methods and plans for use in commercial field monitoring programs. Relative-cost reliability (Wilson 1994) is the ratio of the costs of two or more sampling methods and was computed as:

$$C_1/C_2 = n_1(T_1 + t_1)/n_2(T_2 + t_2)$$

Where C = cost per sample for each sample method or sample unit size, n = required number of samples needed to provide a density estimate with a specified level of precision, T = time required to collect a sample for each sample method or sample unit size and t = time to move from sample unit to sample unit. The time in seconds to move from one sample unit to the next was standardized at t = 15 sec. The visual sampling method employeed in Texas was used as the standard to which the other sample methods/plans were compared. Relative cost-reliability was used to select the optimum sample method and plan. The lowest relative cost reliability value represents the optimum sample method.

Results and Discussion

Taylor's power law effectively modeled the mean/variance relationship for all thrips age classes and both sample methods (Table 1). Except for visual sampling of thrips nymphs, Taylor's a-coefficient was less than one for all thrips age classes and sample methods. This result is likely an artifact of curve fitting or random sample variability (Wilson 1994).

The effect of age class on thrips aggregation was evident for both sample methods. Higher values of Taylor's parameters for nymphs relative to adults, and the decrease in the proportion of immature thrips infested plants for a given mean, indicate that immature thrips exhibit a more aggregated spatial pattern relative to adult thrips (Table 1). This behavioral attribute was not unexpected, as immature thrips tend to hide in the terminals of the cotton plant and are less mobile than winged adults. Wilson and Room (1983a) reported similar findings for *Heliothis* spp. age classes.

Table 1. a and b of Taylor's power law and coefficient of determination.

Thrips age classes	a	b	R^2
Cup Sample Method			
Adult	0.6147	1.0760	0.92
Nymph	0.9389	1.3149	0.95
Pooled	0.7166	1.2205	0.89
Visual Sample Method			
Adult	0.6889	1.1291	0.96
Nymph	1.1608	1.4473	0.88
Pooled	0.9171	1.1569	0.86

Table 2. Relationship between proportion infested cotton leaves and a mean thrips density of one per cotton leaf.

	Proportion Infested (PI)	
Thrips age classes	Cup	Visual
Adult	0.73	0.72
Nymph	0.69	0.67
Pooled	0.72	0.67

The relationship between observed and estimated proportion of infested leaves was strong, with R^2 values in excess of 0.83 for both sample methods across all age classes. The estimated P(I) for the nominal economic threshold of one thrips per leaf was very similar between the two sample methods and thrips age classes (Table 2). Nevertheless, these slight differences resulted in significant differences in the required number of samples needed to estimate a mean thrips density of one thrips per leaf. As a means of simplification, the estimated P(I) was standardized across all cotton maturity stages. The cup sample method would require a maximum sample number of 28, compared to 31 for the visual. However, the time needed to take a sample for the binomial plans has yet to be calculated, so the most cost reliable sample method remains to be determined. Regardless of sample method, the enumerative sample plans required a >56% increase in the number of samples needed to estimate the same density as the binomial sample plans (Table 3 and Figure 2). The average sample times for the enumerative sample plans were 79.1 and 43.6 seconds per sample for the visual and cup sample methods, respectively. Sample number requirements were similar for both sample methods, however, the cup sample method was more cost effective, with a relative efficiency of 0.55. Even though the cup sample method is more cost efficient when using enumerative sampling, the binomial sampling plan requires far fewer samples to make a management decision and will undoubtedly be much more cost effective.

Results and Discussion (continued)

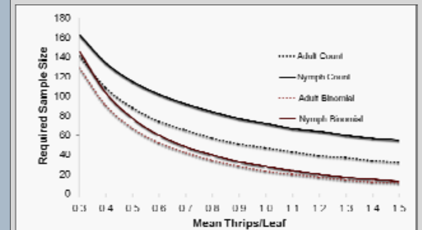

Figure 2. Sample size as a function of thrips mean density per cotton leaf (cup sample method)

Table 3. Required number of samples needed to estimate the nominal threshold of one thrips per cotton leaf.

	Enumerative Sampling		Binomial Sampling	
	Cup	Visual	Cup	Visual
Adult	47	43	26	25
Nymph	72	72	28	31
Combined	54	57	24	30

Summary and Conclusions

1. Taylor's power law effectively modeled the thrips sample data from both sample methods. Taylor's coefficients suggested that thrips nymphs tended to be more closely grouped than adult thrips, regardless of sample method.
2. The relationship between the P(I) cotton leaves and thrips mean density was also modeled well by using the method of Wilson and Room (1983).
3. Development of the sample plans indicated that the binomial sample plan, regardless of sample method, required significantly fewer samples to make a management decision.
4. Sample size requirements between the sample methods for the binomial sample plan, although similar, favored the cup sample method, as it required only 90% of the effort of the visual sample plan.
5. The binomial sample plan will be field tested in 2011.

Literature Cited

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Acknowledgements

This project was funded by Cotton Incorporated CORE Projects and in part by Plains Cotton Growers, Inc.