WITHIN-PLANT DISTRIBUTION PATTERNS OF THE COTTON FLEAHOPPER (HEMIPTERA: MIRIDAE)

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Abstract

The standard method for estimating cotton fleahopper abundance involves whole-plant examinations and direct counts of fleahoppers on plants. This procedure, however, becomes increasingly arduous and time-consuming as plants increase in size. We examined the distribution of cotton fleahopper adults and nymphs on plants to determine whether sampling only the terminal portion of plants provides reliable population estimates. Fleahopper distribution patterns were examined in seven commercial fields during the initial three or four weeks of squaring in 2007 and 2008. Examinations were performed three days a week and twice each day (0800-1130 h, 1300-1630 h) to reveal potential time-of-day sampling effects. Overall, the mean numbers of fleahoppers observed during the morning and afternoon sampling periods were statistically similar. However, significantly more adults and nymphs were observed in the terminal of plants than below the terminal during both sampling periods. When the total numbers of fleahoppers (adults and nymphs combined) observed on plants were regressed on the numbers of fleahoppers found in the terminal of those plants, the relative variation and R^2 values of the model were 28 and 0.89, respectively. Based on the slope of the regression, the terminal accounted for 75% of all fleahoppers observed on plants. Our results suggest fleahopper population estimates obtained from sampling only the terminal portion of plants are adequate for pest management programs, but this sampling practice does not provide the level of precision typically required in population research.

Introduction

The cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), has a preference for wild weed hosts, but adults will move to and reproduce in cotton as preferred hosts begin to senesce in late spring and early summer (Reinhard 1926, Holtzer and Sterling 1980). Both adults and nymphs damage cotton plants by feeding on the sap of young flower buds (squares) and terminal growth, which can result in excessive fruit loss and abnormal plant growth (Metcalf and Flint 1928, Almand et al. 1976). Although effective insecticides exist, accurately determining the need for or timing of insecticide applications is difficult.

Currently, action thresholds for fleahoppers are based primarily on the combined densities of adults and nymphs on plants (Kerns et al. 2008, Parker et al. 2008). The standard method for assessing fleahopper abundance involves whole-plant examinations and direct counts of adults and nymphs on plants. This procedure, however, becomes increasingly arduous and time-consuming as plants increase in size. Consequently, many producers avoid or neglect scouting for fleahoppers, and instead base treatment decisions on other factors such as plant growth stage or the need to treat for other insect pests. Because the timing and intensity of fleahopper movement into cotton varies yearly, treatment decisions based on these other factors often result in untimely or unnecessary insecticide applications. In other instances, economic infestations of fleahoppers may go undetected and untreated in the absence of sampling.

We examined the distribution of cotton fleahopper adults and nymphs on cotton plants to determine whether sampling only the terminal portion of plants provides reliable population estimates. This sampling practice is gaining popularity among extension agents in Texas because it is less time-consuming and laborious. However, information regarding the accuracy and precision of population estimates acquired with this procedure, relative to the standard whole-plant examination method, is needed before this sampling practice can be recommended for use in fleahopper management programs or population research.

Materials and Methods

The distribution of cotton fleahopper adults and nymphs on cotton plants were examined in three commercial fields in 2007 and in four fields in 2008. Fields were distributed among Burleson and Robertson Co., TX and were planted using conventional practices and varieties for that area. Examinations were confined to plants within a 0.5-ha area in each field that was divided into 25 equal-sized plots (15 rows x 12 m long) in a 5-by-5 arrangement. Fields were

sampled three days a week (MWF) during the initial three or four weeks of squaring unless production practices (e.g., pesticide application) or rainfall prevented sampling. Observations were made in the morning (0800-1130 h) and again in the afternoon (1300-1630 h) to reveal potential time-of-day sampling effects. On each sampling occasion, one row within the center seven rows of each plot was systematically selected, and two plants within each selected row were visually examined in the field for fleahoppers. Thus, a total of 50 plants were examined in each field during each period. The numbers of adults and nymphs observed within and below the terminal of each plant were recorded, and respective counts were summed. Respective totals for each field were used as model inputs in subsequent analyses. The terminal was defined as the terminal bud and top two nodes with fully expanded leaves on plants with ≤ 7 nodes. The terminal bud and top four nodes with fully expanded leaves constituted the terminal on plants with ≥ 8 node. Plant height, node count, and fruiting profile were assessed weekly on 50 plants in each field to provide supporting information. All fields were sampled in the same order each day to minimize potential time-of-day sampling variation, and a different row was selected on each sampling date until all rows had been sampled at least once. Thereafter, the sampling row order was repeated until the experiment was concluded.

Data for adults and nymphs were analyzed separately using a two-way mixed-model analysis of variance (PROC MIXED, SAS Institute 2004). Because current action thresholds are based on the combined abundance of adults and nymphs, a third analysis was performed with counts of adults and nymphs combined. In each analysis, fixed effects in the model contained terms for sampling period (morning, afternoon), location of fleahopper (terminal, below terminal), and their interaction. Random effects included year, field nested within year [field(year)], and sample date nested within field [sample date(field)]. Corrected denominator degrees of freedom were obtained using the Kenward-Roger adjustment (DDFM=KR option of the MODEL statement). Estimates of least-square means and corresponding standard errors were obtained using the LSMEANS statement, and differences among levels of fixed effects were identified using the ADJUST=TUKEY option of the LSMEANS statement.

The relationship between the total numbers of fleahoppers observed on plants and the numbers of cotton fleahoppers observed within the terminal of those plants was assessed using PROC REG (SAS Intitute, 2004). Similar to the mixed-model analysis, counts of adults and nymphs were combined as well as analyzed separately. In each case, data were pooled across years, fields, and sampling periods to examine the respective relationships under a wide range of fleahopper densities and environmental conditions. The R option of the model statement and residual-by-predicted plots were used to identify outliers and diagnose nonlinearity or nonconstant error variance. Additionally, the STB and CLB options of the MODEL statement were used to obtain standardized parameter estimates and associated 95% confidence limits.

Results & Discussion

In both years of the study, sampling was initiated and terminated in fields when plants averaged 5 to 6 and 10 to 12 nodes, respectively. The average height of plants sampled in 2007 ranged from 11 to 54 cm and from 10 to 47 cm in 2008. Overall, population densities of fleahoppers (mean ± SE per 50 plants per sample period per sample date) in 2007 (adults, 22 ± 2; nymphs 12 ± 2) were considerably higher than those observed in 2008 (adult, 10 ± 1; nymph, 5 ± 1). Nevertheless, similar population trends were observed between years. In general, adult population levels peaked in fields between the second and third week of squaring, and substantial numbers of nymphs (> 10 nymphs per 50 plants) were not observed in fields until this time.

Overall, the mean ± SE numbers of adult fleahoppers observed during the morning (7.4 ± 2.5) and afternoon sampling periods (8.6 ± 2.5) were statistically similar (F=2.58; df=1, 173; P=0.110). This was also the case for nymphs (morning, 3.9 ± 1.5; afternoon, 4.0 ± 1.5; F=0.05; df=1, 179; P=0.823), and when counts of adults and nymphs were combined (morning, 11.2 ± 3.8; afternoon, 12.6 ± 3.8; F=1.45; df=1, 175; P=0.230). However, differences were detected between the numbers of fleahoppers observed within and below the terminal of plants (adult, F=32.99, df=1, 168; P<0.001; nymph, F=51.58; df=1, 173; P<0.001; combined, F=59.56; df=1,169; P<0.001). In all cases, the mean numbers of fleahoppers observed within the terminal were significantly higher than those observed below the terminal of plants (Table 1). The location-by-sampling period interaction was not significant for adults (F=1.05; df=1, 168; P=0.306), nymphs (F=0.03; df=1, 173; P=0.853), or when counts of adults and nymphs were combined (F=0.57; df=1, 169; P=0.452), indicating the respective densities of fleahoppers within and below the terminal of plants remained consistent between the morning and afternoon sampling periods. Consequently, time-of-day sampling effects were not observed.

Table 1. Mean ± SE numbers of cotton fleahoppers observed within and below the terminal of 50 cotton plants sampled at two time periods of the day during the initial three to four weeks of squaring (2007 and 2008).

Time (CDT)	Stage	Terminal	Below terminal
0800-1130 h	Adult	9.1 ± 2.55a	5.8 ± 2.55b
	Nymph	6.0 ± 1.61a	1.7 ± 1.61b
	Adult + nymph	15.0 ± 3.84a	7.3 ± 3.84b
1300-1630 h	Adult	10.9 ± 2.58a	6.2 ± 2.58b
	Nymph	6.2 ± 1.65a	1.8 ± 1.65b
	Adult + nymph	17.2 ± 3.89a	7.9 ± 3.89b

Within a row, values followed by different letters are significantly different (α=0.05; Tukey-Kramer test).

A significant relationship was detected between the total numbers of adult fleahoppers observed on plants and the numbers of adults observed within the terminal of those plants (F=401.60; df=1, 102; P<0.001). This also was the case for nymphs (F=1,846.16; df=1, 69; P<0.001) and when counts of adults and nymphs were combined (F=810.07; df=1, 103; P<0.001). The model with the best fit (R^2) and lowest relative variation (RV=SE/$\overline{x}$*100) was observed for nymphs, followed by the model in which counts of adults and nymphs were combined (Table 2). Based on the slopes of the regressions (Table 2), approximately 65% of adults and 78% of nymphs observed on plants were located within the terminal portion of plants. When counts of adults and nymphs were combined, the terminal accounted for 74% of all fleahoppers observed on plants.

Table 2. Relationship between the total number of cotton fleahoppers observed on 50 cotton plants and the number of cotton fleahoppers observed within the terminal of those plants.

Stage	n	Slope		Intercept		R^2	RV
		Mean ± SE	(95% CL)	Mean ± SE	(95% CL)		
Adult	104	1.55 ± 0.08	1.40 – 1.70	0.48 ± 1.02	–1.54 – 2.50	0.80	39
Nymph	71	1.28 ± 0.03	1.22 – 1.34	–0.01 ± 0.39	–0.78 – 0.77	0.96	18
Adult + nymph	105	1.34 ± 0.05	1.25 – 1.44	2.18 ± 1.04	0.12 – 4.25	0.89	28

Using RV as an indicator of precision, Southwood (1978) and Pedigo (2002) suggested sampling procedures that provided RV values near 25 were adequate for pest management programs, but values near 10 should be sought for population research. Based on these criteria, our results suggest population estimates obtained by sampling only the terminal portion of plants are adequate for fleahopper management programs. However, our findings indicate this sampling practice does not provide the level of precision typically required for population research.

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