COMPARISON OF SWEEP-NET AND STEM-COUNT TECHNIQUES FOR SAMPLING PEA APHIDS IN ALFALFA

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ABSTRACT

The accuracy, precision and efficiency of stem-count and sweep-net techniques were compared for sampling the pea aphid, *Acyrthosiphon pisum* (Harris), in alfalfa. Density estimates by both techniques were highly correlated (r = 0.87). Both techniques were similar in sample precision and efficiency, but stem counts provided more accurate density estimates than the sweep net technique. The stem count technique is an accurate and efficient alternative to the sweep net for sampling pea aphids in alfalfa.

Key Words: Sampling, pea aphid, *Acyrthosiphon pisum*, *Medicago sativa*.

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INTRODUCTION

An acceptable sampling technique should provide reliable and precise density estimates while minimizing sampling cost. The pea aphid, *Acyrthosiphon pisum* (Harris), typically has been sampled in alfalfa, *Medicago sativa* L., with the sweep net (Fenton and Howell 1957; Saugstad et al. 1967). Sweep-net counts of pea aphids in alfalfa are influenced by a number of factors including plant height, temperature, humidity, cloud cover, wind speed, and rainfall (Saugstad et al. 1967). Furthermore, sweep-net counts are relative and difficult to translate into counts per stem or unit area. Except for sparse populations, stem counts have been found to be more accurate and reliable for sampling the spotted alfalfa aphid, *Therioaphis maculata* (Buckton), and blue alfalfa aphid, *Acyrthosiphon kondoi* Shinji, in alfalfa (Bishop and McKenzie 1982; Fenton and Howell 1957; Rohitha and Penman 1981). Recently, Hutchinson et al. (1988) developed fixed-precision sequential sampling plans for the pea aphid in alfalfa using a single-stem sampling procedure. However, the accuracy, precision, and efficiency of sampling pea aphids in alfalfa using a stem count technique has not been investigated. We compared the precision and efficiency of sampling pea aphids in alfalfa using sweep-net and stem-count techniques.

MATERIALS AND METHODS

Sweep-net and stem-count techniques were compared in established stands of alfalfa which were 1-4 years old. Stands were fertilized and managed for hay production following extension recommendations. Three fields were sampled 4

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times during the first growth cycle in 1984, and 4 fields were sampled 5 times during the first two growth cycles in 1985. Pea aphids were sampled from 1000 to 1600 hr using both techniques at 8 randomly-selected areas of about 0.3 ha in each field. Weather conditions during sampling were sunny to cloudy, 15-29°C, 40-90% RH and 0-10 mph wind speed. A sweep-net (38 cm diameter) sample consisted of taking 20 pendulum sweeps in a straight line with one sweep net sample being estimated to cover 10 m^2. A stem-count sample consisted of 30 stems that were cut every 1-2 m while walking in a straight line. Stems were cut carefully so as to minimize the number of dislodged aphids. Stems were placed in a 26-cm diameter funnel with a 1-liter jar containing 70% ethanol attached to the base of the funnel and vigorously beaten against the side of the funnel to dislodge aphids. The mean stem height of 10 stems taken from the 30 stem sample was measured. Stem density was measured in a 0.09-m^2 area near each sample set. To compare the accuracy of sweep and stem counts, the number of aphids/stem was estimated for each sweep sample as the number of aphids/sweep divided by the estimated number of stems/sweep sample (10 m^2). On two sample dates, stems from each sample were bagged after beating and inspected in the laboratory for aphids that did not dislodge. Aphids collected by both techniques were sorted and counted in the laboratory. The times required to collect samples in the field and sort and count aphids in the laboratory were recorded for both sampling techniques.

The relative variation (RV) of each technique was calculated for each set of data where RV= (SEM/$\bar{x}$)100. RV provides a measure of sampling precision with lower RV values indicating better precision (Pedigo et al. 1972). The efficiency of each technique also was calculated as the relative net precision (RNP) where RNP= 1/(cost × RV)100, with cost = time (human-min) required for a sample. Efficiency improves as RNP declines. Mean RV and RNP of each technique were compared using a t test (Steel and Torrie 1960). Additionally, the association between pea aphid density estimates collected by both techniques was determined using Pearson's correlation coefficients. A multiple regression procedure was used to calculate a formula for estimating pea aphids densities per stem from sweep-net samples. Slope values were compared for similarity between years using a test of homogeneity of regression (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Pea aphid densities ranged from 0-15 aphids/stem and 0-80 aphids/sweep. Stem count samples could be collected without dislodging most pea aphids, because > 95% of the aphids were collected using the funnel procedure. Relative variation ranged from 14.9 to 55.6% for stem-count samples and 8.7 to 47.7% for sweep-net samples. Mean RV was not significantly different between the two sampling techniques in either year (Table 1). Stem counts required an average of 2.67 human-min to collect and sort with 2.11 human-min being required for collection and 0.56 human-min required for sorting and counting aphids. The times required to collect and sort a sweep-net sample were 0.68 and 2.19 human-min, respectively, for a total sample time of 2.88 human-min. Stem counts required more effort to collect in the field than sweep samples, but sweep samples required more effort to sort and count aphids than stem counts. Calculation of sampling efficiency as measured by RNP showed no significant difference between the two techniques in either year (Table 1). Consequently, the precision and efficiency of

Table 1. Mean (± SEM) relative variation (RV) and relative net precision (RNP) of two techniques for sampling pea aphids in alfalfa.

Year	Technique	N	RV*	RNP†
1984	Stem-count	12	24.5 ± 1.3	1.58 ± 0.10
	Sweep net	12	27.4 ± 2.1	1.38 ±0.14
	t-value		1.192 ns	1.191 ns
1985	Stem-count	18	26.5 ± 2.3	1.58 ± 0.12
	Sweep net	18	20.2 ± 2.3	2.07 ± 0.20
	t-value		1.945 ns	2.100 ns

* RV = (SEM/$\bar{x}$)100.

† RNP = 1/(Cost × RV) x 100 where cost is 2.673 and 2.875 human-min/sample for the stem-count and sweep net techniques, respectively.

sampling pea aphids at the densities encountered in this study were not substantially different between the two techniques. Cuperus et al. (1982) observed that stem counts had a lower coefficient of variation and required less time than sweep-net samples for sampling pea aphids in alfalfa, but these authors did not directly compare the precision and efficiency of the two techniques. Furthermore, Saugstad et al. (1967) found that sweep-net samples were influenced by a number of environmental factors and concluded that sweep-net samples were not precise enough for critical population comparisons.

Stem counts provided much higher population density estimates per stem than sweep-net samples. Sweep netting collected only 2.5% in 1984 and 4.3% in 1985 of the pea aphids collected per stem using the stem count technique. Thus, stem counts provided more accurate estimates of pea aphid densities than sweep net sampling without a loss of sample precision or efficiency. Fenton and Howell (1957) also found that stem counts were much more accurate than sweep-net samples, for sampling *T. maculata* in alfalfa with sweep-net samples collecting 2-22% of the aphids collected using the stem count procedure. Sweep-net samples, however, were more effective than stem counts for detecting very sparse populations of *T. maculata*. *Acyrthosiphon kondoi* Shinji was best sampled in short alfalfa ($\leq$ 12 cm) by a suction removal device, but the stem-count technique was a more accurate and effective procedure in taller and rapidly growing alfalfa because an unacceptable percentage of aphids were dislodged by the area removal technique in tall alfalfa (Rohitha and Penman 1981).

Sweep-net and stem counts of pea aphids were highly correlated ($P < 0.001$) in both years with $r = 0.86$ in 1984 and $r = 0.90$ in 1985 and a combined value of $r = 0.87$. A test of the homogeneity of slopes indicated that the relationship between sweep-net and stem counts was not highly significantly ($F = 2.62$; df = 1,26; $P = 0.02$) different between years. Data for both years were combined, and a regression equation was generated to estimate pea aphid density/stem from sweep net counts. The resulting formula was pea aphids/stem = $-9.9873 + 0.3080 (SW) - 0.00008 (SW)^2$, $R^2 = 0.88$ where SW = number of pea aphids/sweep sample. Alfalfa stem height, which ranged from 10-55 cm during the study, did not account for a significant ($F = 0.30$; df = 1,26; $P = 0.59$) amount of the variation between the two techniques. The high degree of variability explained by the equation suggests that pea aphid density per stem can be estimated from sweep-net counts.

Our results demonstrate that the stem count technique provides an accurate and efficient alternative to sweep netting for sampling pea aphids in alfalfa. This conclusion is consistent with other studies with the pea aphid and other aphid species (Bishop and McKenzie 1982; Cuperus et al. 1982; Fenton and Howell 1957; Rohitha and Penman 1981) which found that the stem count technique is an accurate, precise and efficient technique for sampling aphid populations under most conditions in alfalfa. A 30-stem count technique currently is used in Georgia to sample the alfalfa weevil, *Hypera postica* (Gyllenhal), for the alfalfa pest management program (Hudson 1988). Our results suggest that pea aphids also could be sampled simultaneously using the stem count technique thereby substantially reducing sampling costs of both species.

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