

WITHIN-FIELD DISTRIBUTION OF THREE HOMOPTERAN SPECIES
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ABSTRACT

Sugarcane fields composed of either 'CP 70-321' or 'NCo 310' were sampled during 1993 and 1994 for three species of homopteran insects. The West Indian canefly, *Saccharosydne saccharivora* (Westwood), was the most abundant species collected with densities reaching over 40 per shoot. Population densities varied significantly throughout the season in 1993 but were similar in 1994. No difference in densities were found between sugarcane cultivars. Both the sugarcane delphacid, *Perkinsiella saccharicida* Kirkaldy and the leafhopper *Draeculacephala portola* Ball, were found in low numbers (< 1.0 per shoot). *P. saccharicida* reached its highest levels later in the season, and 'CP 70-321' shoots harbored more individuals than 'NCo 310' shoots. Although *D. portola* densities were low, differences among fields and between cultivars were found. Aggregation, as measured using Taylor *a* and *b* coefficients, was shown to be greater for *S. saccharivora* than the other species.

INTRODUCTION

Sugarcane (interspecific hybrids of *Saccharum*) has been commercially grown in a three-county area of southern Texas since 1972. Stemboring pyralids, Mexican rice borer, *Eoreuma loftini* (Dyar), and sugarcane borer, *Diatraea saccharalis* (F.), have been the most serious insect pests of the industry (Meagher et al. 1994); however, other insects are active in the Texas sugarcane agroecosystem. The homopteran fauna was described in two earlier reports (Meagher et al. 1991, Meagher et al. 1993), although only basic survey information was noted and sampling was conducted using a large suction device that did not estimate insects per shoot. Three Auchenorrhyncha homopteran species, *Saccharosydne saccharivora* (Westwood) (Delphacidae), *Perkinsiella saccharicida* Kirkaldy (Delphacidae), and *Draeculacephala portola* Ball (Cicadellidae), were relatively abundant in these earlier surveys.

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The West Indian canefly, *Saccharosydne saccharivora*, has been associated with sugarcane in the Caribbean and in North, South, and Central America for centuries (Metcalf 1969). This delphacid has historically caused varying degrees of economic damage (Charpentier 1970), and has been documented in all continental sugarcane-producing states (Charpentier 1970, Hall 1988, Meagher et al. 1993). The sugarcane delphacid, *P. saccharicida*, first noted in the continental United States in Florida in 1982 (Sosa 1985), was documented in Texas in 1989 (Meagher et al. 1991) and was recently discovered in Louisiana in 1994 (White et al. 1995). This insect can cause economic damage (Wilson 1987) and is a vector of *Fijivirus* sp., the causal agent of Fiji disease of sugarcane (Francki and Grivell 1972, Egan et al. 1989). *D. portola* is commonly collected in sugarcane (Hall 1988, Meagher et al. 1993) and is sporadically captured in other grass crops (Wilson et al. 1973, Hawkins et al. 1979). It was reported to be a vector of chlorotic streak in sugarcane (Abbott and Ingram 1942) until further investigation proved otherwise (Abbott et al. 1961).

An understanding of the spatial patterns of an insect can aid in developing sampling plans (Southwood 1978). Spatial patterns are affected by intrinsic factors such as oviposition pattern and immature dispersal, extrinsic factors such as host quality and environmental toxicants, and estimation procedures such as sampling plan parameters, sample unit size, number of samples, and sampler bias (Wilson 1994). Spatial patterns can depend on population density, with low densities tending to be indistinguishable from uniform or random, and high densities of most insects tending to be aggregated. The efficiency of a resulting sampling plan must balance cost considerations against the quality of the information provided. The objective of the present research was to describe the within-field distributions of *S. saccharivora*, *P. saccharicida*, and *D. portola* adults and nymphs in two sugarcane cultivars and calculate sample sizes based on a defined level of reliability.

MATERIALS AND METHODS

Fields and Sampling. Commercial sugarcane fields of either 'CP 70-321' or 'NCo 310' in different Lower Rio Grande Valley locations were sampled in 1993 and 1994. Field size ranged from 6.3 to 15.7 ha. Sampling was initiated during February or March and terminated in late August due to sugarcane harvesting. Every effort was taken to maintain a biweekly timetable; however, weather conditions or irrigation schedules occasionally delayed sampling in individual fields. Each field was sampled a total of 8 to 10 times per year. Sampling was conducted during mid- to late morning by randomly selecting 30 shoots (randomized by selecting sugarcane row and number of paces within row) per field. Starting at the base of the shoot, leaves were gently pulled back and the number of adults and nymphs present was recorded.

Statistical Analysis. Means per shoot for each species were calculated for each weekly sample taken in each field. Numbers were compared among weeks, among fields and between cultivars using analysis of variance (PROC GLM, SAS Institute 1996). Counts were square root ($y + 0.5$) transformed before analysis, but untransformed means are shown in tables and figures.

Spatial dispersion was investigated using Taylor coefficients, $S^2 = a \bar{x}^b$ (Taylor 1961, 1984). Taylor coefficients were estimated by fitting $\ln(S^2) = \ln a + b \ln(\bar{x})$ (PROC REG, SAS Institute 1996). Estimates for a and b were compared using analyses of variance (PROC GLM, SAS Institute 1996) to examine the effects of cultivar.

Wilson and Room (1982) presented the following equation for estimating sample size where the goal was to estimate population density with a defined level of reliability:

$$n = (t_{\alpha/2} / D_{\bar{x}})^2 a_{\bar{x}}^{(b-2)},$$

where $t_{\alpha/2}$ is the standard normal variate for a two-tailed confidence interval, $D_{\bar{x}}$ is a proportion defined as the ratio of half the desired CI to the mean ($D_{\bar{x}} = [CI/2] / \bar{x}$ for enumerative sampling), and a and b are Taylor coefficients. This equation permits one to estimate required sample size (n) over a range of densities for any species and sample unit whose Taylor

coefficients are known. Required sample size was calculated using $t_{\alpha/2} = 1.645$ and $D_{\alpha} = 0.2$.

RESULTS AND DISCUSSION

Higher numbers of *S. saccharivora* were collected in 1993 than 1994, with seasonal means of 23.7 and 3.0 individuals per shoot, respectively. Populations varied significantly throughout the season in 1993 ($F = 3.2$; $df = 23, 42$; $P = 0.0005$), with peak populations occurring in May (Fig. 1a). Meagher et al. (1993) also found more *S. saccharivora* during May-June than March-April. Migrating adults into young or ratoon sugarcane fields can boost populations to over 30 per shoot during the initial phases of colonization (Metcalf 1969), and this was exemplified in one field with a mean of 44.7 ± 7.8 (SE) West Indian canefly per shoot. These large populations in a 'NCo 310' field near Elsa contributed to significant among field variation ($F = 6.9$; $df = 3, 42$; $P = 0.0007$). However, *S. saccharivora* were found in similar numbers between cultivars ($F = 1.8$; $df = 1, 42$; $P = 0.1898$). In 1994, only among field variation was significant ($F = 2.9$; $df = 4, 31$; $P = 0.0403$) (Fig. 1b). *S. saccharivora* adults and nymphs were the least mobile and were easy to locate because they were usually present on the underside of leaf blades.

Perkinsiella saccharicida populations were low in both years, not exceeding 1.0 per shoot. Low numbers of *P. saccharicida* were found in our previous study; however, sampling was conducted using a large suction sampling method that probably wasn't appropriate for this insect (Meagher et al. 1993). In 1993, populations varied significantly throughout the season ($F = 3.0$; $df = 23, 42$; $P = 0.001$), with peak populations occurring in July and August (Fig. 2a). Among field and cultivar differences were not significant ($P > 0.05$). Seasonal abundance studies in Florida showed that sugarcane delphacid population densities ranged widely field-to-field (Sosa 1985) and increased during the summer months with peak densities approaching 7.5 per shoot in October and November (Sosa et al. 1986). However, maximum population densities in Louisiana sugarcane were found to be 0.3 per shoot (White et al. 1995). We were not able to sample during fall and winter due to sugarcane harvesting. Peak population densities of this insect in southeastern Queensland, Australia were as high as 96 adults and 335 nymphs per shoot (Allsopp and Bull 1990).

In 1994, seasonal, among field, and cultivar variation were all significant ($P < 0.05$). Population densities were low from February through April, but were higher from May through August (Fig. 2b). 'CP 70-321' shoots contained more sugarcane delphacid adults and nymphs than 'NCo 310' shoots ($F = 5.6$; $df = 1, 31$; $P = 0.0242$) (Fig. 2c). Cultivar preference and population development differences have been shown experimentally and in field studies (Chang and Ota 1978, Taniguchi et al. 1980, Allsopp and Bull 1990).

Densities for *D. portola* were also low, never exceeding 1.0 per shoot. Earlier research showed this species to be the most commonly collected (Meagher et al. 1993). However, samples in that study were taken from sugarcane and surrounding grasses using a large suction sampler, and it is possible that most of the *D. portola* population was collected from non-sugarcane hosts. Population densities in both years were not different across weeks ($P > 0.14$) but were different among fields and between cultivars ($P < 0.05$). In 1993, densities were higher in 'NCo 310' than 'CP 70-321' shoots (0.2 ± 0.01 vs. 0.12 ± 0.01 , respectively; $F = 14.5$; $df = 1, 42$; $P = 0.0004$) (Figs. 3a and 3b), while in 1994, 'CP 70-321' shoots harbored more leafhoppers than 'NCo 310' shoots (0.37 ± 0.02 vs. 0.27 ± 0.02 , respectively; $F = 4.4$; $df = 1, 31$; $P = 0.0444$) (Figs. 4a and 4b). *D. portola* were the most active species collected, with nymphs present in the whorls and adults in whorls and on leaf blades.

Taylor *a* coefficient ranged from 0.85 for *D. portola* to 4.15 for *S. saccharivora*, and *b* ranged from 0.95 for *D. portola* to 1.55 for *S. saccharivora* (Table 1). Taylor coefficients for *P. saccharicida* were in between those values and were similar to coefficients calculated for *P. saccharicida* nymphs and adults sampled in Australian sugarcane fields (Allsopp and Bull 1990). Taylor *b* coefficient was significantly > 1.0 for *S. saccharivora* in both years and *P. saccharicida*

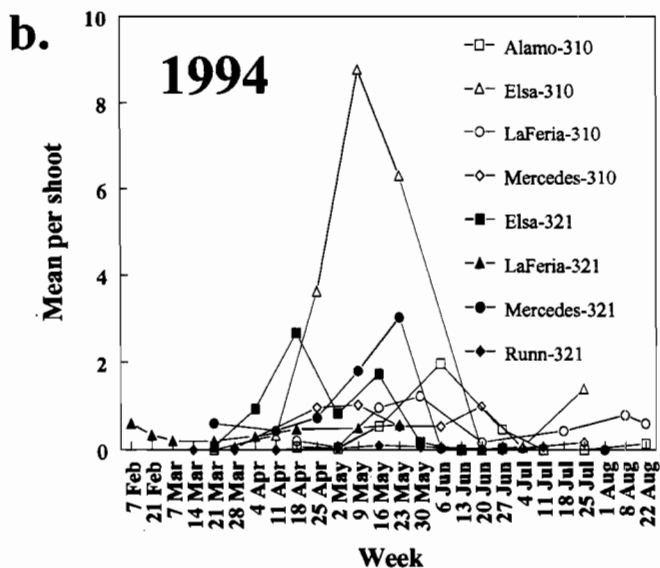
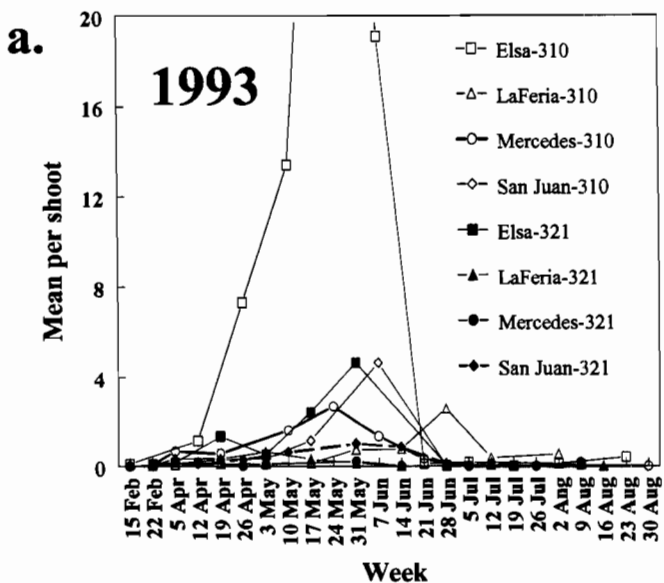


FIG. 1. Seasonal density of *Saccharosydne saccharivora* in eight sugarcane fields, lower Rio Grande Valley, Texas, 1993 and 1994. The density on 23 May 1993 was 44.7 per shoot. '310' refers to cultivar NCo 310, '321' refers to cultivar CP 70-321.

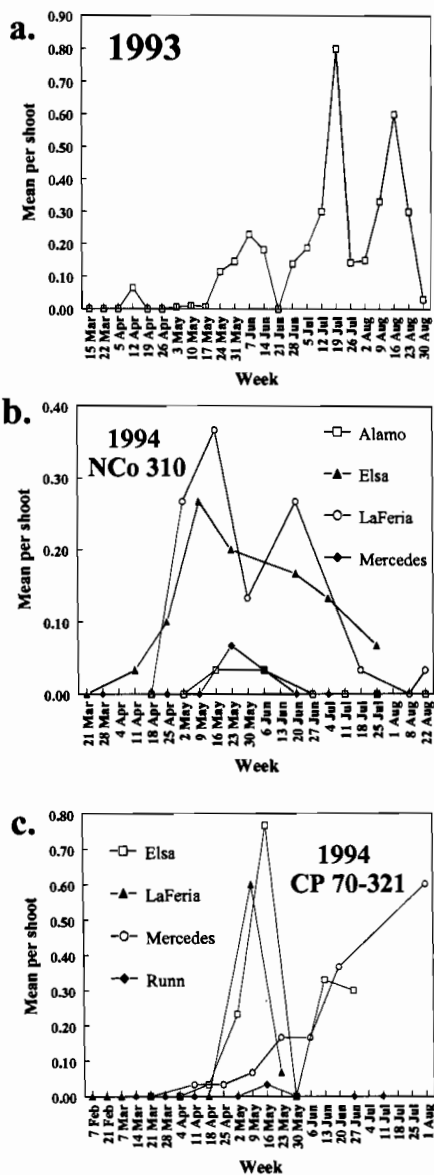


FIG. 2. Seasonal density of *Perkinsiella saccharicida* in sugarcane for 1993 and 1994, lower Rio Grande Valley, Texas. Means in 1993 are across both cultivars and all eight fields. Means in 1994 are for four fields for each of the cultivars NCo 310 and CP 70-321.

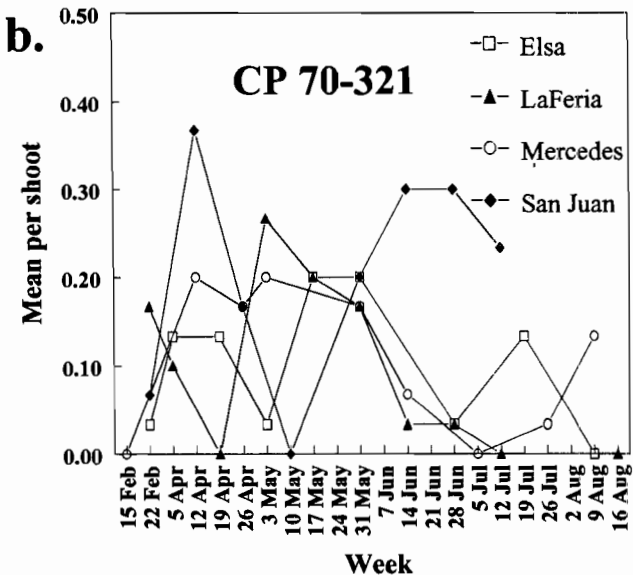
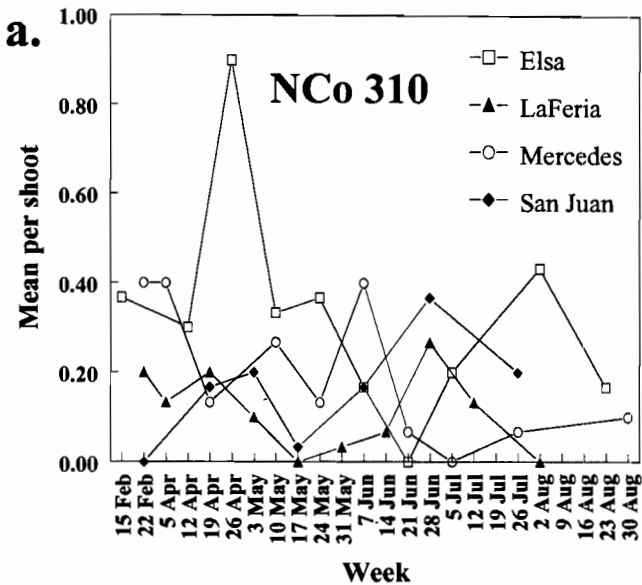


FIG. 3. Seasonal density of *Draeculacephala portola* in sugarcane for 1993, lower Rio Grande Valley, Texas. Means are for four fields for each of the cultivars NCo 310 and CP 70-321.

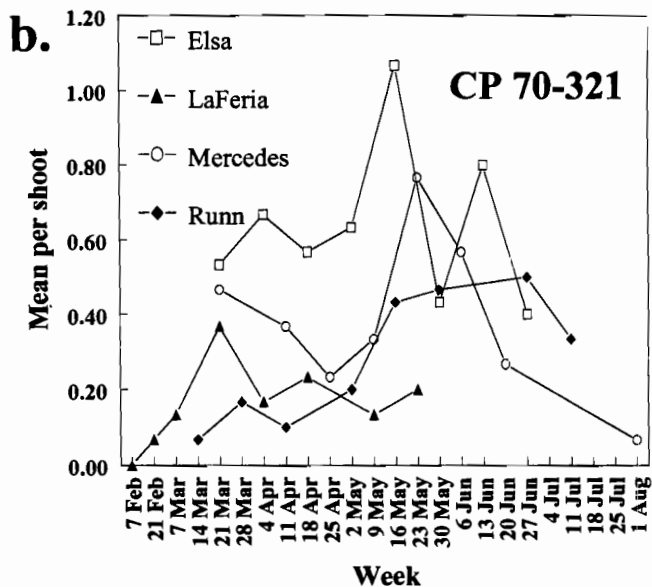
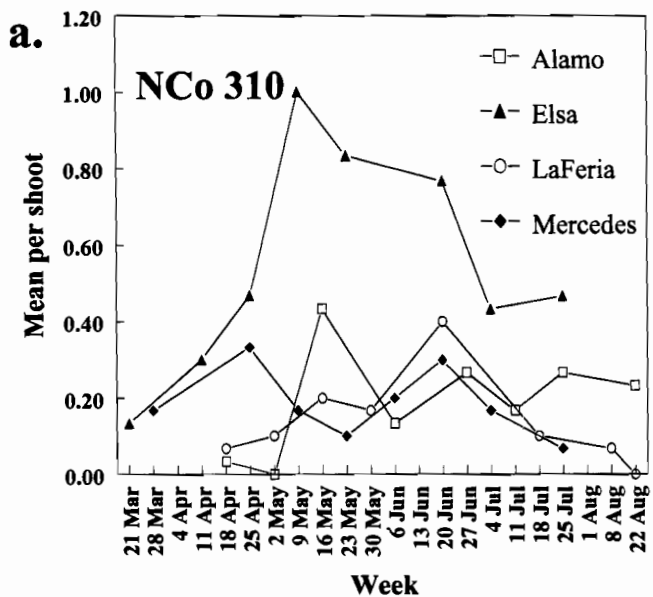


FIG. 4. Seasonal density of *Draeculacephala portola* in sugarcane for 1994, lower Rio Grande Valley, Texas. Means are for four fields for each of the cultivars NCo 310 and CP 70-321.

in 1993. For each species, there were no differences in Taylor a or b between sugarcane cultivars ($P > 0.15$). These results indicated that under Texas sugarcane growing conditions and for commonly encountered densities, *S. saccharivora* has a more aggregated spatial pattern than the other two species.

TABLE 1. Taylor Coefficients for Three Species of Homoptera in Texas Sugarcane, 1993-1994.

Species	Year	a (\pm SEM)	b (\pm SEM)	r^2	n
<i>Saccharosydne saccharivora</i>	1993	4.15 (1.07)	1.55 (0.03) ^a	0.974	58
	1994	3.16 (1.12)	1.43 (0.06) ^a	0.907	53
<i>Perkinsiella saccharicida</i>	1993	1.48 (1.11)	1.13 (0.04) ^b	0.953	34
	1994	1.10 (1.12)	1.02 (0.05)	0.935	32
<i>Draeculacephala portola</i>	1993	0.85 (1.07)	0.95 (0.03)	0.934	61
	1994	0.87 (1.11)	0.95 (0.06)	0.794	61

a, b, Slope significantly different from 1.0, F -test, $P < 0.01$, 0.001, respectively.

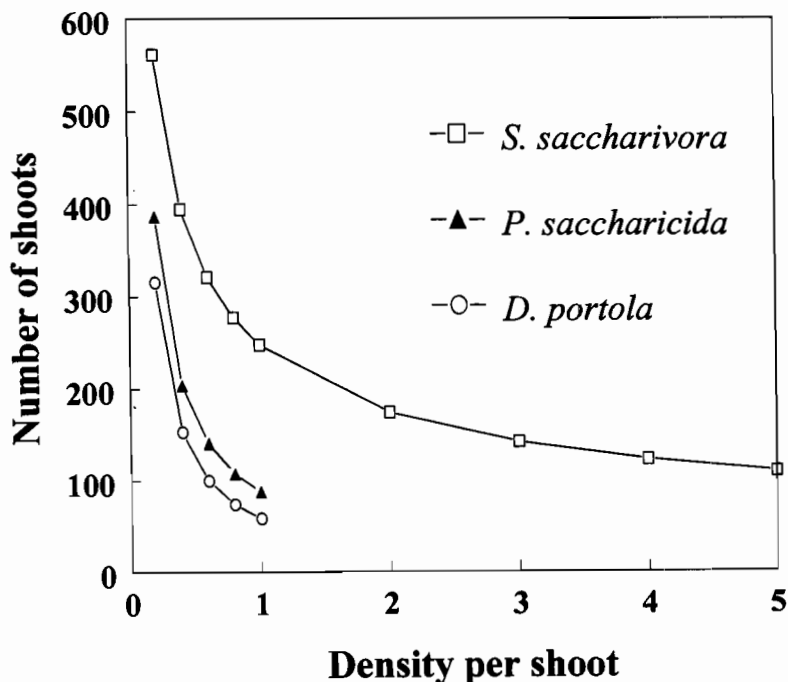


FIG. 5. Estimated number of shoots required to estimate *Saccharosydne saccharivora*, *Perkinsiella saccharicida*, and *Draeculacephala portola* densities in Texas sugarcane.

Due to this aggregation, larger sample sizes would be needed to estimate mean number of *S. saccharivora* per shoot than the other two insects. For example, the number of shoots required to obtain 90% confidence limits which are $\pm 20\%$ of the mean of 5.0 *S. saccharivora* would be ca. 100 shoots (Fig. 5). The results presented here provide the first within-field distribution sampling data for these homopteran species in Texas sugarcane and form a baseline of information for growers, consultants, and researchers.

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