Title: Improved Transect Sampling to Enhance Efficiency of Corn Rootworm Monitoring

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Abstract:
Crop monitoring for corn rootworm remains the best means to assess fields at risk from this pest if replanted to corn the following year. Use of sequential sampling reduced the minimum sampling time to about 20 minutes or less per field per visit to make a management decision. With previous funding from the NYSIPM program we developed a transect sampling protocol for sequential sampling that reduced sampling time by an additional 6 minutes per field. Our previous results were based on a relatively small number of fields (3) and simulations over a realistic but limited range of adult CRW spatial dispersion patterns. In this project we compared transect sampling to the commonly used systematic "W" system in 13 fields. Field trials using systematic, and transect sampling in each field were used to compare the categorization of adult corn rootworm densities into "above" or "below" threshold with a sequential sampling plan. Efficiency measured in time to reach a decision, number of corn plants evaluated, and time divided by plants observed were compared between sampling methods. The two methods did not differ significantly in the number of plants evaluated or in the categorization of corn rootworm populations. Transect sampling resulted in a significantly shorter time divided by plants observed (38 s), than the systematic sampling method (70 s). Based on these field results transect sampling reduces sampling time 46% compared with systematic sampling and thus could be used to reduce total sampling times substantially. While much larger number of fields sampled in this study almost certainly increased the range of spatial dispersions encountered there is still some question regarding the performance of transect sampling in fields where CRW adults are highly aggregated or clumped. Computer simulations on a wide range of dispersal patterns are continuing but early results suggest that transect sampling performs acceptably well even at the extreme ranges of potential aggregation. Furthermore, our ongoing assessment of adult CRW dispersion utilizing sticky card does not indicate extreme levels of aggregation. Computer simulations and analysis using spatial statistics continue but all of our results to date suggest that transect sampling is effective and reliable.

Background and Justification:
Over the past decade, the western corn rootworm (CRW) has become established as the predominant insect pest of field corn in New York The more assertive nature and economically damaging capacity of western CRW, compared to the previously dominant northern CRW species, has increased grower awareness and concern of potential risks of CRW. Corn grown for silage is at particular risk from corn rootworm injury (Davis 1994). Western corn rootworm is also responsible for dramatic increases in overall soil insecticide use. A pesticide survey conducted in 1985 reported that 13.8% of the New York acreage received a soil insecticide (Specker et al 1986). By 1989 this figure had nearly doubled to 24.8% of the New York acreage being treated with a soil insecticide (Martiz Market Research, Inc.). In 1994, a PIAP survey of NYS producers found that 70.3% of grain corn acres and 17.3% of silage corn acres were routinely treated with an insecticide. Presumably, a large proportion of insecticide use was targeted towards CRW control (Partridge et al 1995).

This same PIAP survey found that producers utilized pest presence based on scouting as their criteria in making insecticide-use decisions on about 50% of NYS's grain (51.7%) and silage (50.3%) corn acres. In a 1998 survey of NYS field crop producers, Waldron (unpublished) found that 77% of the 1074 growers polled monitored their field corn. Forty-two percent of those monitoring did so 2-3 times per season, 21% - more than 4 times per season, and 8% did so weekly. Nearly 60% of those surveyed expressed concern (26% low, 20% moderate, and 13% high level of concern) for the amount of time required to monitor crops for pest problems. Clearly, growers are interested in monitoring as a means to enhance pest management decisions but feel time required to do so is an element of concern.

Prior to 1991, CRW monitoring procedures required an assessment of CRW beetle numbers on five plants in each of eleven areas within a field. This activity could take as much as ninety minutes per field (Sawyer, 1985). To simplify this protocol and time commitment, Shields et al (1991) developed a sequential CRW sampling method enabling producers to assess a twenty acre or smaller field for CRW in twenty minutes or less. This sampling method has helped increase adoption of IPM practices to optimize management of CRW.

The most common currently used sequential sampling pattern involves systematically covering most of the field following a "W" pattern. The feasibility of replacing the current sampling pattern with a simpler and less time-consuming transect (straight line) pattern was assessed in 2001. Computer simulations demonstrated that treatment decisions based on transect sampling would have an acceptably low error rate (10%) over a range of realistic CRW densities (0 to 2 adults per plant). This error rate represented a decrease in accuracy of less than 1% compared to systematic sampling. Field trials using transect, systematic "W", and random sampling methods in each field were used to compare the categorization of adult CRW densities into "above" or "below" threshold with a sequential sampling plan. Efficiency measured in time to reach a decision, number of corn plants evaluated, and sampling time per plant were compared between sampling methods. The three methods did not differ significantly in the number of plants evaluated or in the categorization of CRW populations. Transect sampling resulted in significantly shorter mean sampling time per plant (38 s) than either systematic (78 s) or random sampling methods (166 s). Based on these results transect sampling reduces sampling time per plant by 40 s or 51% compared to systematic sampling and thus could reduce total sampling times substantially.

This level of time saved could equate to substantial monetary savings for growers and scouts. Based on saving almost a minute per plant using transect sampling compared to sequential "W" sampling, an average of 18 plants required to make a decision in New York (Shields et al. 1991), and a value of $40 per hour for sampling (D. DeGolyer, personal communication), transect sampling would result in a savings of over $8 per visit to a field. This magnitude of savings could be especially important for trained pest management consultants who can routinely visit over 14 fields in a day. With fields sampled for CRW as many as four times in a season this could represent savings of over $30 per field over the season. Since transect sampling represents a simplification of the current sampling protocol, existing materials from the sequential plan could still be utilized. An additional benefit of transect sampling is that by reducing the amount of time in the field and the number of crosses between rows, this method has the potential to reduce sampler fatigue.

In this project we extended our earlier work by examining the accuracy of our results over a wider range of conditions that a grower might encounter. We addressed this by 1) sampling a larger number of fields then in our previous work, 2) simulating a wider range of potential spatial dispersion patterns and 3) quantifying the actual spatial dispersion of CRW adults. While the second and third component are still proceeding they have not yet produced any results that lead us to question the reliability of transect sampling even over a wide range of potential conditions. We provide a full report on the first component of this project.

Methods

Field trials were conducted in 13 fields in central New York. Corn rootworm were sampled using transect, and systematic "W" sampling methods by four observers with each using both methods in every field. Fields were sampled in August 2003. A rectangular area of 160 corn rows by 1056 corn plants per row was sampled for each field. With spacings of 76.2 cm between rows and 22.86 cm between plants this equates to a rectangle 122 m wide by 229 m long and a total area of approximately 28,000 m^2. All sampling excluded the head rows. For all methods the sequential sampling scheme developed by Shields et al. (1991) was used to categorize the corn rootworm population into above or below the recommended threshold of one beetle per plant. Plants were successively chosen using one of the two methods until the upper or lower stop point was reached. Plants were exhaustively searched in the same manner regardless of sampling method, western corn rootworm were counted as 1.0 and the infrequent, less damaging northern corn rootworm were counted as 0.5. For the transect method, a row was randomly selected excluding the five outermost rows and every tenth plant was counted. For the systematic "W" method observers excluded the five outermost rows then started on the first row and within the first 10 plants and designated that location 1,1. From this initial location the "W" pattern was executed by crossing over three rows and advancing 81 plants for each successive plant until four passes were made back and forth across the field. Thus, the first nine plants counted were: (row, plant) 1, 1; 3, 82; 6, 163; 9, 244; 12, 325; 15, 406; 18, 487; 21, 568; 24, 649. Total sampling time was measured from start of sampling until a management decision was reached. Total sampling time per observation was calculated by dividing total sampling time by the number of plants evaluated.

The effect of sampling method on total sampling time, number of plants evaluated, and total sampling time per observation were analyzed with an analysis of variance (PROC MIXED; SAS Institute 1996). Field and observer were included in the model as blocking factors. Total sampling time and total sampling time per observation were log-transformed to alleviate heteroscedasticity. Treatment means were compared using *t*-tests with Tukey's adjustment to control experimental error.

Results and Discussion

Based on the results of field trials, the three sampling methods did not differ in their categorization of corn rootworm populations using sequential sampling. Each observer categorized each corn rootworm population the same way using all three methods.

In the field, the two sampling methods differed significantly in total time to make a decision ($P = 0.0001$; Table 1). Transect sampling resulted in shorter total time to make a decision than systematic "W" sampling. Transect sampling reduced total time to make a decision by about 6 min compared with systematic "W" sampling.

Total mean sampling time per observation (total time divided by plants evaluated) also differed significantly between sampling methods ($P = 0.0001$: Table 1). Transect sampling resulted in shorter time per observation to make a decision than systematic "W" sampling. Transect sampling resulted in significantly shorter mean sampling time per observation (38 s) than either systematic "W" sampling (70 s). Based on these results transect sampling reduces sampling time per observation by 32 s or 46% compared with systematic "W" sampling.

The two methods did not differ significantly in the number of plants evaluated to make a decision ($P = 0.51$; Table 1). Thus the reduction in sampling time per observation (total time divided by plants evaluated) was due to reduced travel between plants not time at each plant.

Computer simulations and analysis using spatial statistics continue but all of our results to date suggest that transect sampling is effective and reliable and that it can potentially reduce the amount of sampling time and thus increase the utilization of sampling and reduce the amount of unnecessary pesticide use.

Table 1. Field comparison of sampling method efficiency (mean ± S.E)

	Transect	Systematic "W"
Total time (min)	7.90 ± 0.75a	13.98 ± 1.17b
Total time per observation (min)[a]	0.63 ± 0.03a	1.16 ± 0.05b
Plants evaluated	12.58 ± 1.04a	13.62 ± 1.48a

Different letters within a row indicate a significant difference between treatments, $P \leq 0.05$; Tukey's *t*-tests.

[a]Means of the total time spent in each field divided by the number of plants counted in that field for each sampling method. Since corn rootworm on plants were counted in the same manner regardless of sampling method, variation is due to differences in travel time between plants.

Literature Cited:

Davis, P.M. 1994. Comparison of economic injury levels for western corn rootworm (Coleoptera: Chrysomelidae) infesting silage and grain corn. J. Econ. Entomol. 87:1086-1090.

Hills, T.M. and D.C. Peters. 1971. A method of evaluating postplanting insecticide treatments for control of western corn rootworm larvae. J. Econ. Entomol. 64: 764-765.

Partridge, M.S., C. Coffman, W.G. Smith, D.A. Rutz. 1995. Pest and Pesticide Use Assessment and Personal Protective Equipment Use for Field Corn Production Systems in New York State for 1994. NAPIAP Report. 106 pp. Funded by NAPIAP – USDA: 94-EPIX-1-0179. http://pmep.cce.cornell.edu/piap/fieldcorn94/index.html

Shields, E.J., R.B. Sher, and P.S. Taylor. 1991. Sequential sampling plan for Northern and Western corn rootworms (Coleoptera: Chrysomelidae) in New York. J. Econ. Entomol. 84:165-169.

Southwood, T.E. 1978. Ecological Methods. Pg 26. Halsted Press, New York.

Specker, D.R., D.A. Rutz, W.G. Smith, J.K. Waldron, R.I. Carruthers and K.S. Goh. 1986. Pest and pesticide use assessment in dairy cattle/field and forage production systems in the Northeast, 1986. 150 pp.