E. J. DIETRICK, E. I. SCHLINGER, AND M. J. GARBER

Vacuum cleaner principle applied in

Sampling Insect Populations

in alfalfa fields by new machine method

Accurate estimates of the total insect population of an alfalfa field can be obtained by the use of newly developed equipment and sampling techniques. All species of insects—each in relation to the whole as well as one to another—and measurement of the separate life stages, and appraisal of the ratios of the beneficial biological control organisms to the harmful plant-feeders can be made.

The new method of sampling uses a suction machine that works on the principle of the vacuum cleaner and gathers all of the alfalfa-inhabiting insects into a collecting bag, made of organdy cloth, so completely that reliable estimates of the true population levels per acre can be derived. A high-speed fan driven by a gasoline motor was adapted to suck insects, from square-foot areas of an alfalfa field, into the collecting bag. The insects from five separate square-foot areas constitute a single machine sample unit.

Two persons are needed to obtain a sample properly. With the motor fan drawing air into a 15′ × 14″ flexible tube, the operator carries the collecting nozzle above his head from one square-foot drop to another drop. An assistant keeps the motor fan away from the area to be sampled to avoid disturbing the insects. The operator lowers the nozzle over the hay and pushes it quickly to the ground. The operator cuts the alfalfa stems encircling the nozzle. The nozzle is then tilted enough to allow the operator to cut the alfalfa stems within the nozzle and shake them to help the air flow dislodge insects held by the leaves. The nozzle is again pressed to the ground for a few seconds over the exact outline of the square-foot area. Then, as the assistant raises the nozzle, the operator quickly fits a smaller adapter hose into the nozzle. The increased air suction in the smaller hose gathers the heavier insects and the trash left in the square-foot area. Five separate square-foot areas are sampled before the collecting bag is removed, quickly taped shut before the motor fan is stopped, and a fresh bag installed. A five-square-foot sample can be obtained in 10 minutes by an experienced team of collectors.

Gathered insects must be kept alive. Portable ice boxes provide refrigeration from the time of collection until the samples are ready to be transferred to funnel separators in the laboratory. A very short exposure of the samples to carbon dioxide anesthetizes the insects so they can be transferred to the separators. In the laboratory the material is spread over transparent plastic-coated screen trash trays in the funnels and the covers are placed in position. The funnels are blacked out except for a beam of light directed up from below the alcohol jar into the center of the funnel. Automatic timers turn the lights on and off every 15 minutes to avoid boiling of the alcohol. Seventy-five-watt glocoil heaters, controlled by powerstats, warm the samples slowly to 120°F. Thus, gradients of heat and light, as well as any positive geotropic responses, cause the insects to leave the duff and become

Continued on next page

INSECT POPULATIONS

Continued from preceding page

trapped in the alcohol. After 24 hours' separation time, every insect has been trapped in the alcohol and the samples are ready to count.

An experiment compared five net sweeps with five-square-foot machine samples. The net sweeps were taken by one person using the standard sweep net with the average sweep stroke measured to cover approximately 10 square feet. Twenty replicates of paired sweep and machine samples were taken. All insects were counted and grouped by more than 100 different species.

The sets of counts were analyzed in the laboratory. The table on this page shows some of the highlights for 14 representative categories. The means for the 20 counts were adjusted for square footage, in the last two columns of the table, but the statistical data are compared as mean counts for approximately 50 square feet by sweep collection and exactly five square feet by machine sampling.

As a survey of this type called for an analysis of all of the kinds of organisms present, the sample size could not be adjusted for each species, but had to be arbitrarily set for all. The machine sample was set at 5 square feet because this represented the average amount of material which could be spread evenly in the funnel separators.

In general, where the sample means were 10 or above, the data were found to fit the normal distribution. However, where the means were below 10, other distributions gave a better fit.

Summary of Data for Experiment Comparing 5 Net Sweeps with 5 Square-foot Machine Samples

	Means		Machine –Net M.D.[a]	$^{S}MD^{b}$	Distribution	Means adjusted equal areas	
	Net	Machine				Net	Machine
Ladybug larvae	12.70	18.75	6.5*[c]	2.26	N[f]	12.7	187.5
Ladybug adults	0.25	0.50	0.25	—[d]	NB[f]	0.2	5.0
Green lacewing larvae	1.60	15.65	14.05	—	NB, N[e]	1.6	156.5
Tetranychid mites	16.70	36.65	19.95*	7.20	N	16.7	366.5
Bradysia flies	14.50	19.10	4.60*	2.10	N	14.5	191.0
Barborid flies	3.55	117.75	114.20	—	NB, N	3.5	1177.5
Pirate bug nymphs	13.20	43.25	30.05**	3.82	N	13.2	432.5
Pirate bug adults	7.40	5.25	-0.26^{NS}	0.16	NB	7.4	52.5
Aphid parasites males	2.45	6.75	0.70**	0.15	NB	2.4	67.5
Aphid parasites females	9.40	9.60	0.20	—	NB	9.4	96.0
Damsel bug adults	1.00	0.90	-0.003^{NS}	0.006	NB	1.0	9.0
Damsel bug nymphs	0.85	2.25	0.51**	0.18	NB	0.8	22.5
Spotted alfalfa aphid adults	3.30	0.50	–1.00**	0.13	NB	3.3	5.0
Spotted alfalfa aphid nymphs	10.95	3.45	-1.12^{NS}	2.07	NB	10.95	34.0

[a] M.D. Mean Difference.
[b] ^{S}M.D. Error.
[c] *, **, Significant at the 0.05 and 0.01 levels of probability, respectively.
[d] Dispersion indices differed.
[e] Distributions followed different patterns.
[f] N = normal distribution; NB = negative binomial distribution.

There was only one case—spotted alfalfa aphid adults—where the net count was significantly larger than that of the machine. In all other cases the machine counts were larger than or not significantly different from the five net sweep counts. With adjustment to equal areas, all net counts were less than that of the machine.

The major advantage of the machine method of sampling is that it permits the rapid collection of a nearly complete quantitative measure of the insects from the ground surface to the top of the alfalfa plants, even under somewhat adverse conditions. Hay stubble can be sampled as easily as full-grown hay. Furthermore, the collected insects can be separated into preserved, easily countable units.

For most insect species, the machine sampling technique appears to be the only way to gather enough units to make a quantitative study.

E. J. Dietrick is Laboratory Technician in Biological Control, University of California, Riverside.

E. I. Schlinger is Assistant Entomologist in Biological Control, University of California, Riverside.

M. J. Garber is Assistant Biometrician, University of California, Riverside.

Portable machine for sampling field insect populations.

Method of moving machine between sampling areas.

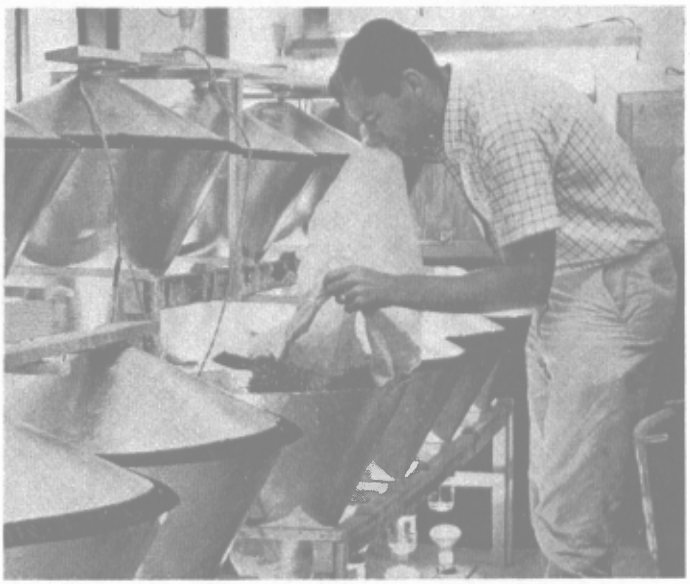
Cutting alfalfa encircling the nozzle of sampling machine.

Clipped stems within nozzle shaken to loosen insects.

Placement of adapter hose for complete sampling.

Increased suction through smaller hose lifts heavy insects.

Collection bag is sealed quickly to prevent escape of insects.



Anesthetized insects put into separators for counting.