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A NEW METHOD OF SAMPLING ULV DROPLETS

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ABSTRACT. The conventional method of sampling ULV droplets from a ground ULV machine is to swing a slide through the aerosol cloud at a distance of 25 feet from the nozzle. The nozzle output velocity of the Leco model HD ULV, however, can be used to impinge the droplets on a slide. A simple "slide pendulum" device is placed 4 feet from the nozzle and gravity is used to accelerate the slide through a cross-section of the cloud. Results are similar to the conventional method, but more consistent and easier to measure. Further experimentation is needed to see if this method can be adapted to other ULV machines.

The standard method of sampling the malathion droplet output of any approved ground ULV machine is described in the American Cyanamid Malathion label as follows:

> A sample of the Malathion aerosol is deposited on a slide by waving the slide as rapidly as possible perpendicular through the aerosol cloud at a distance of 25 feet from the point of discharge. The slide velocity may be increased by attaching it to a 3 or 4 foot stick by means of a spring paper clip.

This technique is widely used to sample the droplet size of most insecticides when they are sprayed through ULV machines.

Clearly, there are weaknesses in this method. The most significant weakness is the impossibility of standardizing skill and technique when a number of different people are collecting samples. The person taking the samples introduces two uncontrolled variables: slide velocity as it is swung through the aerosol cloud, and exact choice of the location of the sampling station.

Slide velocity is especially important in determining numbers of small droplets compared with large droplets. Small droplets will be collected in greater numbers on slides swung with relatively great speed. The slower the slide velocity the more the sample will be biased toward large droplets. On the other hand, too high a slide velocity, and centrifugal force will cause the droplet samples to assume oblong shapes, making them difficult to measure accurately.

Sampling location is important since the aerosol cloud is quite wind sensitive. Even if it is not scattered by wind gusts, at 25 feet the cloud is so diffuse that it is impossible to sample a complete cross section. Thus, the person taking the collection must judge the "best" or most representative area of the mist, and if he is too high or low, or too near the edge, his sample may be unrepresentative. Further, some large droplets will often settle on the slide while he waits for the mist to stabilize, and decides where to take his sample. Last, we can add that it is not especially pleasant to stand in the full blast of the insecticide, even at 25 feet.

We have found that this standard

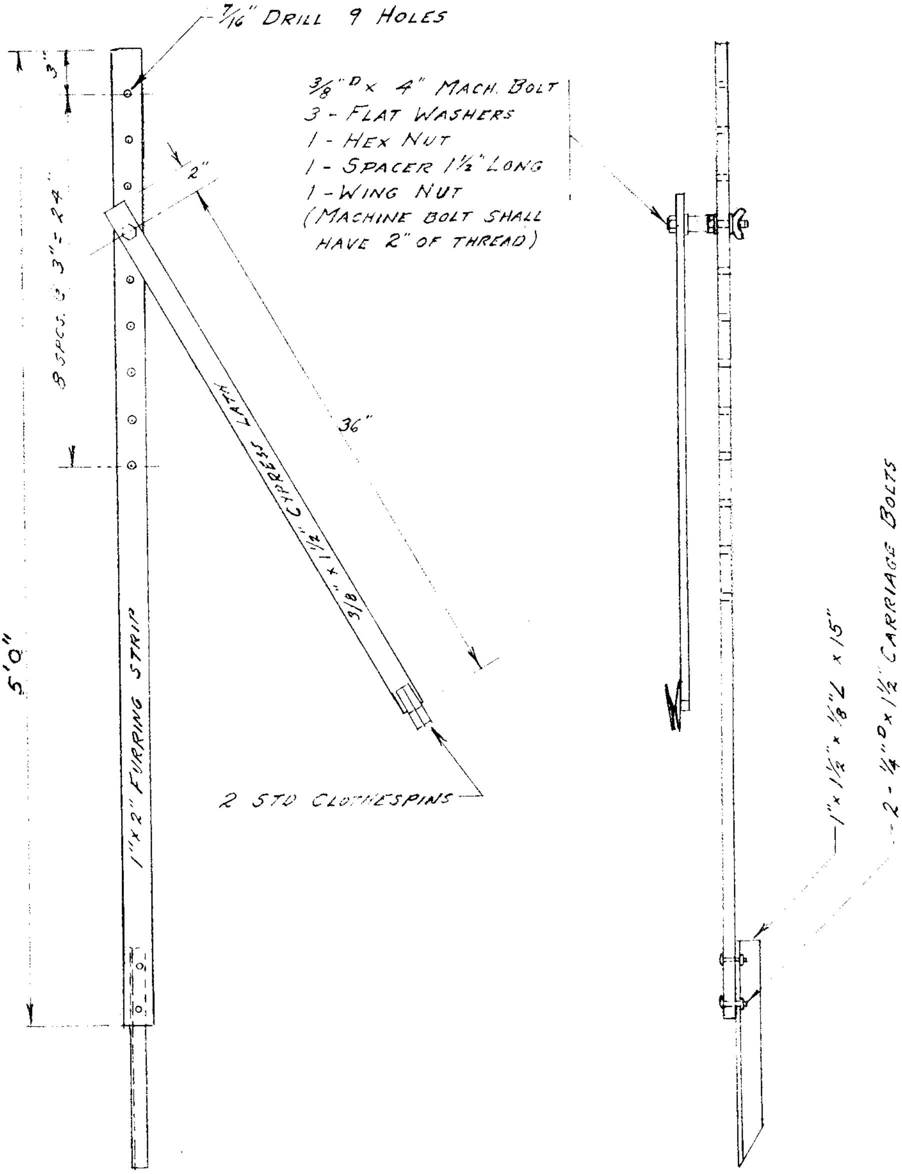

Fig. 1. Construction of sampling apparatus.

method of collection allows a single operator to achieve consistent results that can accurately distinguish different operating conditions among our ULV machines. But we feel that the several variables just described make it difficult to compare the data from different samplers. This paper describes a new method that frees the sampling of ULV droplets from collector-introduced variables.

Materials and Method. The spray machine we used was a Leco ULV (model HD), which has a very high air blast of approximately 200 CFM through a 1⅜″ orifice. The new sampling method utilizes the air blast velocity of the machine to impinge the droplets on the slide. Now, the motion of the slide is used solely to obtain a full and uniform cross section of the aerosol cloud.

The sampling apparatus consists, basically, of two wooden sticks. One is 3′ long and 1″ in diameter with a wooden clothes pin fitted at one end to hold the slide, and a ¼″ hole drilled 2″ from the other end. This is the slide pendulum. It is attached by a long, thin bolt to a 6′ long, 1″ x 2″ stake fitted with a steel spike at the bottom. Holes are drilled in the stake every 3″ from the 3½′ level to the 5′ level. A 2″ spacer is used to keep the slide pendulum separated from the stake. When attached the pendulum should swing with no drag whatsoever. See Fig. I.

To measure the droplet output of a ULV machine, first position its nozzle horizontally. Then, position the stake behind and to the side so that the slide is directly behind the nozzle when the slide pendulum is at a 90° angle to the stake. Both the treated face of the slide and the rod should be exactly parallel to the mouth of the nozzle. The slide should be 4′ behind the nozzle. (This is easily done by using a pre-measured string with a hook at one end that can be attached to the nozzle.) When you have properly positioned the stake, drive it into the ground. Readjust the height of the slide pendulum using the holes in the stake so that the rod and slide are again perpendicular to the stake when the slide is directly in front of the nozzle orifice. See Fig. 2.

When the device is properly set up the arc formed by the slide on the end of the pendulum will pass freely through the entire droplet output of the machine. A sample is taken by letting the slide fall from a 360° (vertical) position downward through the aerosol cloud, and catching it at the apex of its swing. See Fig. 3.

Results and Discussion. All droplets were measured and mass median diameters determined by methods described on the American Cyanamid label, using Teflon coated slides (Anderson and Schulte, 1971). Results are presented in two forms —first, using the criteria set forth by American Cyanamid, and second as the percentage distribution of droplets falling into various size ranges (Mount and Pierce, 1972).

The first set of tests we ran were designed to assess the efficiency of the air blast in impinging droplets on the slides. Five samples were taken using the technique described in the section above, at distances from the nozzle of 1 to 5 feet, at 1-foot intervals. At distances greater than 5 feet, the diameter of the cloud became too great for full sampling. The only significant difference among samples taken at different distances was in the higher preponderance of small droplets the closer the slide was to the nozzle. See table 1.

In further testing, the 4-foot distance was chosen as our standard because it seemed to result in a droplet spectrum comparable to the conventional collection method. This distance provided a cloud 24 inches to 25 inches in diameter that could be readily sampled, and gave an abundance (approximately 100,000) of nearly perfect circle droplets for evaluation.

To check the ability of the new technique to provide consistent data, three samples were taken at the 4-foot distance from the same machine. These data show

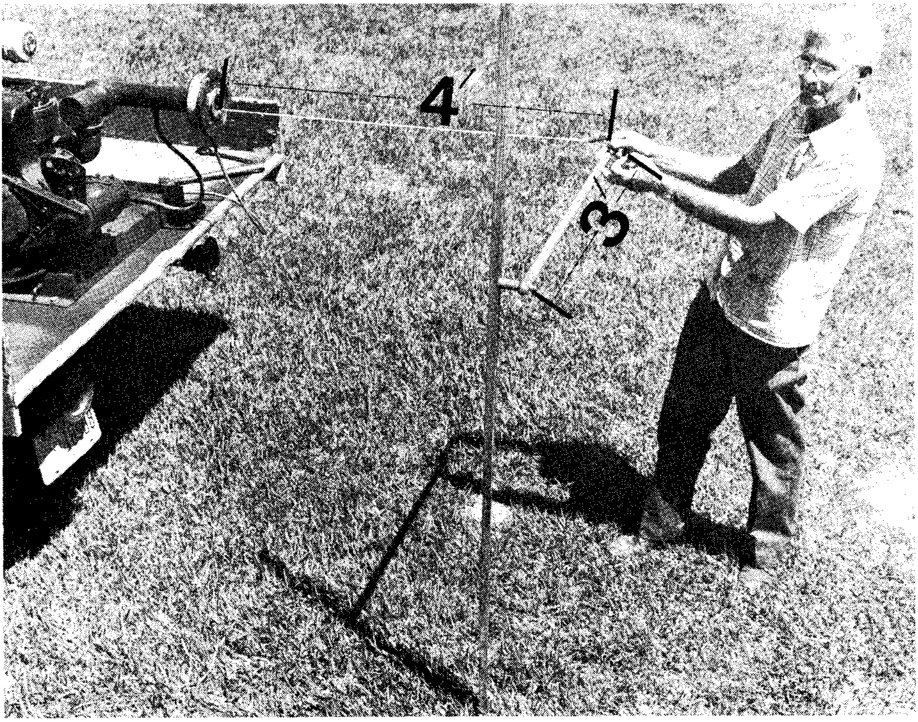

Fig. 2. Positioning of the sampling apparatus.

Table 1. Droplet data obtained by pendulum collection method at 5 1-foot intervals from nozzle.
Machine #202 PSIG—4.5 Oz./Min. Malathion—4.3
Temp. °F–68

Distance	Average Drop Diameter μ	Mass Median Diameter μ	Number Droplets over 48 μ	Number Droplets over 32 μ	Percent 6–18 μ Range	Percent Under 24 μ
1′	6.3	7.4	0	0	59.7	98.1
2′	7.1	9.1	0	1	51.8	87.5
3′	9.1	12.2	0	2	52.5	90.0
4′	11.4	14.3	0	2	54.7	85.6
5′	14.8	16.7	0	4	52.7	83.2

Percent Droplets by Diameter Ranges

Distance	Under 5 μ	5–10 μ	11–20 μ	21–40 μ	Over 40 μ
1′	58	29	11	2	0
2′	60	23	14	3	<1
3′	45	24	26	5	0
4′	27	31	33	9	<1
5′	5	31	47	17	0

Fig. 3. Operation of the sampling apparatus.

that the technique does indeed have a high degree of reliability in repeated samples. See table 2.

Samples were then taken using each method (rapid swing on 3-foot stick at 25 feet, and pendulum at 4 feet) with the machine operating at recommended air pressure, and then at low air pressure (which produces a spectrum unacceptably high in large droplets). All samples were repeated three times. Both methods produce essentially the same results when the machine is operated at low or unacceptable pressure. At normal pressure the results are again similar. The pendulum method, however, shows a more normal distribution pattern of droplets with less emphasis on the larger ranges, and a consequently higher percentage of small droplets. See table 3.

Last, an additional comparison of the collection methods was made using 4 different machines operated at both normal and low pressures. Results were similar to those found previously, and were consistent for all machines.

It can be seen by a comparison of the two sampling methods at either normal pressure or low pressure that the pendulum method at 4 feet produces essentially

Table 2. Droplet data obtained by pendulum collection method at 4′ distance from nozzle. 3 replications

Machine #204 PSIG—4.5 Oz./Min. Malathion—4.3

Temp. °F–68

Slide	Average Drop Diameter μ	Mass Median Diameter μ	Number Droplets over 48 μ	Number Droplets over 32 μ	Percent 6–18 μ Range	Percent Under 24 μ
1	11.4	13.5	0	4	63.6	90.4
2	12.2	13.5	0	3	67.5	92.6
3	11.7	13.3	0	1	64.2	93.2
Average	11.8	13.4	0	2.7	65.1	92.1

Percent Droplets by Diameter Range

Slide	Under 5 μ	5–10 μ	11–20 μ	21–40 μ	Over 40 μ
1	20	38	34	8	0
2	13	35	47	6	0
3	16	40	37	7	0
Average	16.3	37.7	39.3	7	

the same results as the swing method at 25 feet. There is some tendency for the pendulum method to make the normal pressure samples look slightly more acceptable while those at low pressure look slightly less acceptable. As noted, the distribution of droplets into diameter ranges is more nearly correct with the pendulum method. An unexpected result of this work was the uniformity of samples taken by the 25-foot swing method. This obviously occurred because only one person was used to take all the "swing" samples, and he was exceptionally careful.

Table 3. Droplet data obtained using two sampling methods. 25′ swing and pendulum. Normal and low machine operating pressure.

Average of 3 replications

Machine #202 PSIG—Normal 4.5 PSIG—Low 3.

Oz./Min. Malathion 4.3 Temp. °F–70

Machine Pressure	Sampling Method	Average Drop Diameter μ	Mass Median Diameter μ	Number Droplets over 48 μ	Number Droplets over 32 μ	Percent 6–18 μ Range	Percent Under 24 μ
Normal	Pend.	11.4	14.3	0.3	1.7	54.7	85.6
	Swing	13.7	15.1	0.3	4	59.8	83.0
Low	Pend.	15.9	19.2	1.3	12	42.0	70.0
	Swing	15.0	17.6	1.3	12	48.0	72.0

Percent Droplets by Diameter Ranges

Machine Pressure	Sampling Method	Under 5 μ	5–10 μ	11–20 μ	12–40 μ	Over 40 μ
Normal	Pend.	27	30.7	33	9	1
	Swing	7	36.3	45	11.3	1
Low	Pend.	7.3	32	38.3	21.0	1.7
	Swing	6.3	37.3	37	17.7	1.4

CONCLUSION. The new sampling method described will produce a droplet spectrum on a slide which is essentially the same as that produced by the conventional method. However, the new method 1) eliminates several potential sampling errors, 2) avoids the unpleasantness of standing in the concentrated insecticide cloud, and 3) produces more droplets on the slide which are nearly round in shape and thus more accurately measured.

The Leco produces an unusually high output velocity. Further experimentation is needed to see if this method of sampling can be adapted to measure the droplet output of other ULV machines. Moving the pendulum closer to the nozzle and impeding or accelerating its swing through the aerosol cloud in some easily repeatable fashion might be necessary to achieve results comparable to ours run with the Leco. Or it may turn out that other ULV's simply do not produce enough velocity to impinge small droplets on a passive target, and that with these, the swing method will remain the best inexpensive sampling technique.

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