physics which has been publsihed. In contrast, no quantitative data exist to support the widespread, widely accepted conventional wisdom that pesticide spray droplets of "any" size can fall into foliage, and can penetrate to target microhabitats.

TABLE 1
1982 SIZE RANGE AND DROPLET VOLUME DISTRIBUTION: FOLIAR DATA

Drop size range (um)	Average drop size (um)	Frequency distribution %	Cumulative frequency distribution %
2 - 5	3.5	0.00	0.00
6 - 10	8.0	0.33	0.33
11 - 20	15.5	7.81	8.14
21 - 30	25.5	23.51	31.65
31 - 40	35.5	24.48	56.13
41 - 50	45.5	13.83	69.96
51 - 75	63.0	9.00	78.96
76 - 100	88.0	15.15	94.11
101 - 125	105.5	5.89	100.00

VMD = 38u

TABLE 2
1982 SIZE RANGE AND DROPLET NUMBER DISTRIBUTION FOLIAR DATA

Drop size range (um)	Average drop size (um)	Frequency distribution %	Cumulative frequency distribution %
2 - 5	3.5	3.22	3.22
6 - 10	8.0	14.17	17.39
11 - 20	15.5	46.56	63.94
21 - 30	25.5	23.76	87.70
31 - 40	35.5	8.18	95.88
41 - 50	45.5	2.38	98.26
51 - 75	63.0	0.90	99.16
76 - 100	88.0	0.71	99.87
101 - 125	105.5	0.13	100.00

NMD = 13u
Dmax = 110u
Dmin = 3u

The stabilization and formulation studies were approached on the basis of use of purified crystal preparations. The crystals were isolated by renografin gradients, followed by suspension in deionized water. The fluorescence studies were made with crystals solubilized with dithiothreitol. Quartz cuvettes were used to allow study of the absorption and fluorescence emission of the solubilized preparations. In order to determine the effect of a standardized (hard) UV source, crystals were suspended in a quartz cuvette and irradiated for specific periods of time. Aliquots of the suspension were then solubilized and the fluorescence emission obtained. Other aliquots of the crystals were used to determine biological activity. The biological activity studies were limited to BtI because of the ease and speed of the bioassay procedure. At present we are starting bioassay work with cabbage looper (*T. ni*), and with cotton boll worm (*H. zea*). The fluorescence data obtained were not different with Bt (HD-2) crystals and BtI crystals. The fluorescence spectra correspond to protein tryptophan (class B proteins) in which the tryptophan exists in a non-polar environment.

Under the experimental conditions used, BtI and Bt cyrstals are photolytically unstable and their tryptophan fluorescence decreases relative to the time of irradiation. In the case of BtI, that decrease in tryptophan fluorescence is directly related to decrease in biological activity. If tryptophan fluorescence can be correlated with biological activity, then it could be a basis for analytical quality control, by spectroscopy. The tryptophan absorption spectra show no significant differences before and after irradiation.

Encapsulated formulations of BtI crystals with UV-Chek® (Ferro Chemical Co.) were prepared and subjected to irradiation using the same UV source under standardized conditions. Under these conditions, unprotected BtI crystals lost all biological activity after 6 hours. At present we have found no loss in biological activity of encapsulated, protected, samples irradiated continuously over a period of 20 days. In control studies, all adjuvant components of the formulation were shown to have no adverse effect on the mosquito larvae.

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SPRAY SWATH PATTERNS OF SMALL AIRCRAFT AND VERTICAL DISTRIBUTION OF MICROBIAL SPRAY DEPOSITS

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Introduction

Each year in Northeastern United States over 500,000 acres of oak forests are aerially sprayed to prevent massive defoliation by the gypsy moth. In Pennsylvania alone 400,000 acres were proposed for treatment in 1983 with commercial preparation of *Bacillus thuringiensis* (Bt).

Preparations of Bt must be consumed by the pest insect to be effective, and cannot be absorbed through the insect's integument like most of the organic insecticides. Therefore, it is important that the Bt spray deposit be distributed evenly over the feeding surface and in sufficient quantity to be lethal. Consequently, the more efficient and precise the application technique is, the greater chance that the target site will collect an amount that will be efficacious.

Aircraft calibration and lateral spray deposit distribution determinations are generally considered routine activities prior to aerial spray operations, but such results are usually omitted from the literature. Consequently, comparisons between different aircraft is difficult. In addition, the actual relationship between the spray droplet characteristics and their biological activity has vitually been unexplored with microbial pesticides, including those used against the gypsy moth.

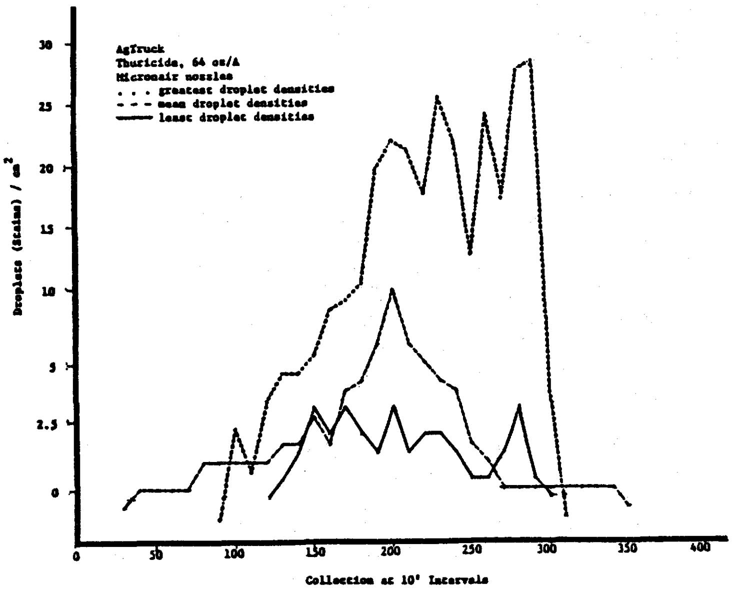
Swath Widths

The term, swath width, is generally defined as "the area (span) in which the amount of spray expressed in various ways equals or exceeds a specified amount thought to produce the requisite effectiveness." In these trials "lateral distribution width" (LDW) was used to mean the detectable spray that was deposited over a surface at various points along a 90° lateral direction on each side of a forward path of the application system.

In 1983 swath width trials were conducted using a Cessna AgTruck®. The aircraft's speed was 120 mph. The nozzle systems used in these trials were the Mini-Micronair (AU5000) and the flat fan, stainless steel No. 8004. Two commercial preparations of Bt, Thuricide 48LV® and Dipel 6L®, were used at the rate of 12 BIU. These formulations were applied at the rate of 64 fl. oz./A. The aircraft was calibrated for a 75' swath width and the spray applied at 40 PSI pressure. White 4 x 5" Kromekote® cards, placed on 2' wire stakes, were spaced at 10' intervals and used to collect the spray emission. The aircraft was then flown 50' over the collection line and into the wind. Most of the LDW applications were made in the early morning hours and when no wind could be detected.

The LDW resulting from the Bt formulations dispersed by the Micronair AU5000 nozzles ranged from 90 to 270 feet with a mean of 188 feet. In a few trials low force cross winds were present and did skew the droplet distribution slightly.

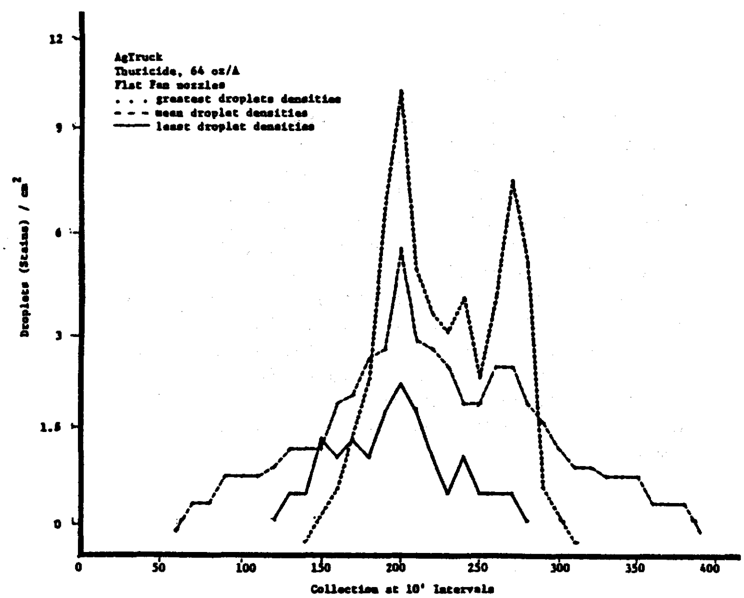
The following figure illustrates the droplet (stains) density spray patterns over the 400' detection line:



Three curves are presented, one showing the greatest droplet density, another the mean droplet density of 12 Micronair trials, and another the LDW curve depicting the trial having the least droplet densities.

The mean number of droplets/cm^2 for the total LDW of the various trials varied from 0.5 to 12.5 with an overall average of 3.5 droplets/cm^2. Peak droplet densities ranged from 28 to 3 droplets/cm^2. In the 24 trials, including Thuricide and Dipel, there was considerable variation in the LDW and/or swath width with regards to droplet density.

The following figure illustrates the droplet density (stains) spray patterns over the 400' detection line for the flat fan No. 8004 nozzles:



These spray droplet patterns show the greatest droplet densities/cm^2, the mean droplet density of the 12 flat fan trials and the LDW curve depicting the trial resulting in the least droplet densities.

The total LDW for Bt dispersed by the flat fan nozzles in a single flight pass ranged from 160 to 400 feet. For all flat fan trials the overall LDW mean was 255 feet. In general, meterological conditions were stable, but wind speeds were detected in some trials ranging from 7 to 10 knots/hour. The mean number of droplets/cm^2 for the total LDW of the formulations ranged from 0.4 to 4.3 with an overall average of 1.8/cm^2. Some collection sites obtained droplet density means of 10 droplets/cm^2, while others were much lower.

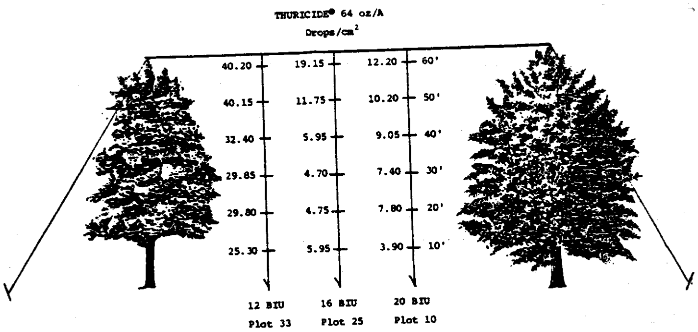
When the replicated trials or flight passes were compared considerable variation was found in droplet density and spray deposited in the LDW patterns. With such variation between trials, it would seem that an applicator would have a problem in selecting an LDW pattern that would more accurately characterize the aircraft type and be used in its calibration. Although some of the prescribed techniques for determining aircraft-spray swath widths or LDW are suitable, there remains the need to develop standard techniques that will provide a more accurate estimation of these parameters for each aircraft type. The following questions still remain unanswered: In calibrating an aircraft should it always be flown into the wind and only when such conditions prevail, or should the swath width determinations be undertaken in "0" wind conditions? What elevations should be used for the swath determinations? Should multiple flight paths be used in addition to a single flight path?

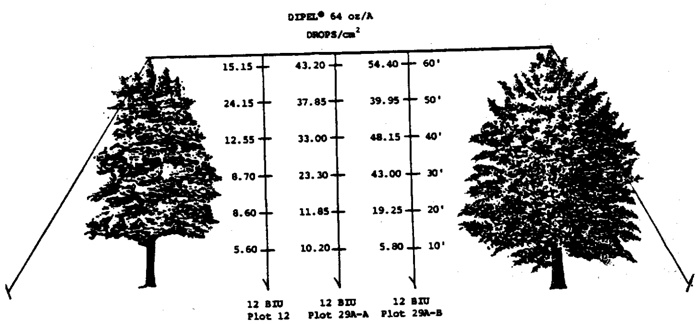
The overall average volume mean diameters (VMD) of the Micronair was 186 μm for Thuricide and 165 μm for Dipel. For the flat fan nozzles, the overall average VMD was 304 μm for Thuricide and 262 μm for Dipel.

Aerial Evaluations

To evaluate spray deposits at various elevations, a series of vertical lines were constructed and secured to a horizontal aerial line. The horizontal line was attached to the canopy tops of two oak trees. Using a cork-paper clip attachment system, collection surfaces could be positioned at various intervals along the upright aerial line, usually at 10' intervals. These aerials were placed in open spaces in oak forests being treated by air with Bt. With this system an evaluation of the physical droplet characteristics including VMD, density, and spray mass per unit area could be made.

The following figures illustrate the droplet densities that were collected at various heights in an oak forest being treated with Thuricide and Dipel at 64 fl. oz./A by air:





When spray droplets were collected at various elevations and their densities compared, the 60' elevation collected at least 3 times more droplets than the 10'. In the case of the Thuricide treatment, the VMD's ranged from 286 to 590 μm. In most trials the bottom card had the largest VMD of 50 μm. These preliminary investigations clearly indicated that additional research is needed to better understand droplet distribution in a free-fall system and within the oak canopy.

GENERAL DISCUSSION

D. SCHMIDT: Having listened to the previous speakers talk about the problems of pesticide aplication, I have a question. "Given the information available and not what you would like to have, and knowing the equipment that the operator has, can you give an estimate of just how effective his spray program will be?"

M. PELLETIER: I really can't answer that question at the operational level -- many times we just cross our fingers.

D. SCHMIDT: I understand your problem as an operator, but I thought that some of our other speakers who have talked about the information they have and what they would like to have would want to know if their operation was going to be a success.

W. SMIRNOFF: Just one comment, your explanation is valid if you study chemicals which are a solution, but with a suspension such as Bt it is not the same. The number of spores per droplet can vary from one to several hundred thousand.

P. FAST: On the contrary, we have laboratory data to show the exact number, or very close to the exact number, of spores and crystals in a droplet.