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ULV Equipment Calibration: Why & How

- How did we get here?
- ULV equipment evolved from Foggers
- Particle size calibrations are required on the label
- Particle size effects efficacy
 - Mosquito impingment
 - Wasted chemical
- Calibration methods



June, 1953

A. W. A. BROWN 2 and D. L. WATSON 3
Veterinary and Medical Entomology Unit, Division of Entomology, Ottawa,
Canada

During 1951 and 1952 a comparative study was made of 5 machines for their ability to control infestations of adult *Aedes* mosquitoes about camps in Canadian woodland. They comprised the Microsol generator (Wilson et al., 1949), the Husman sprayer, 4 a recent modification of the Besler generator (Brescia, 1946; Wilson et al., 1949), the TIFA machine (Dickinson et al., 1948; Horsfall, 1950; Peterson, 1952), and the Dyna-Fog generator (McDufne et al., 1950; Yeomans, 1950).

1 Contribution No. 3052, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada. The results herein reported were obtained by the Division of Entomology in a program of studies on the biology and control of biting flies being carried out on behalf of the Defence Research Board and with the co-operation of that organization and other agencies.

2 Head, Department of Zoology, University of Western Ontario, London, Canada; in the seasonal employ of the Division of Entomology, as Entomologist, when this work was performed.

3 Assistant Entomologist.

4 See article by C. N. Husman, page 134, this issue of Mosquito News. — Ed. Note.

Determinations were made of the drop-, let spectra produced with oil solutions of DDT emitted at various rates; the droplet spectra at various distances downwind; the portions of the clouds that were deposited on the ground; the amount of DDT that reached various distances downwind both in the open and in the woods; and the percentage reduction in landing rates of *Aedes* mosquitoes obtained in woodland for distances up to 400 yd, downwind.

Study had mixed results, but:

They compared 2 – foggers(thermal) and 3 fine mist machines(ULV).

The methods in which the “fine mists” were produced are the three methods still used for ULV sprayers today.

They include:

High pressure nozzle



Air is produced by a compressor at a high pressure (60 – 100 psi), but a low volume. The air flows from the circle around the center hole while the insecticide mixture is metered through the center hole.

Low Pressure Nozzle



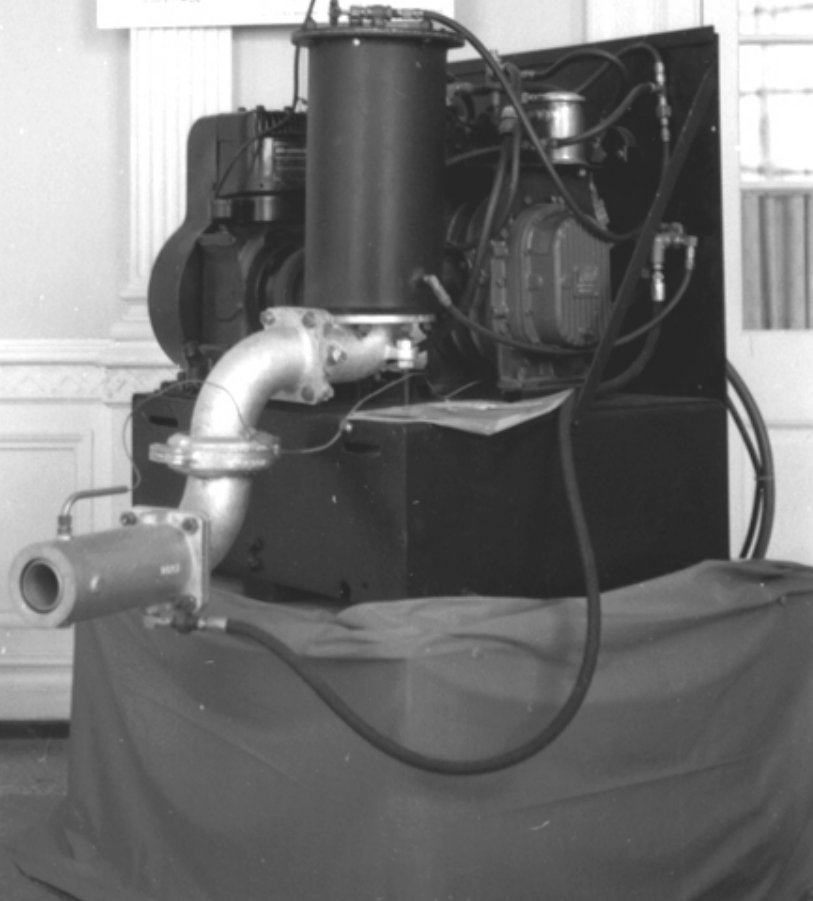
Contrast with the High pressure nozzle it moves a very large volume of air(up to 400 cfm) at a low pressure(4-8 psi).

Rather than a simple hole for the insecticide to emerge into the air blast, the product is “sprayed” into the inside the base of a tapered cup where the air flow draws it out to the edge where a film of insecticide is sheared producing the aerosol.

Rotary Atomizer



The New
TIFA
MODEL 100-E
100 GAL
PER HOUR
*Electric
STARTER
REMOTE
CONTROL*
\$1775⁰⁰



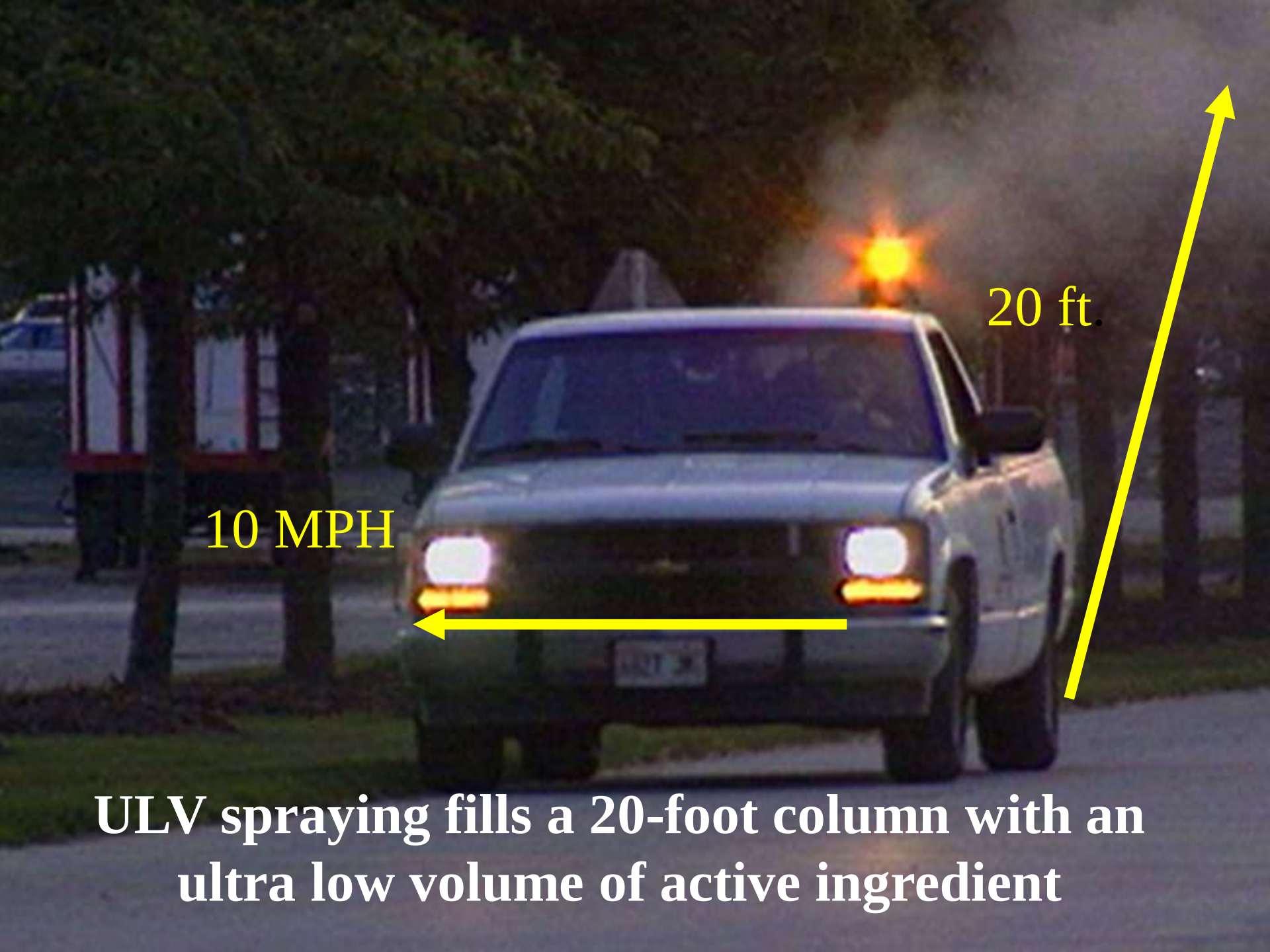
History of Ground Adulticiding

- Development of ULV technology
 - 1965; Knapp, Roberts and Glancey demonstrate ULV aerial application for mosquito control
 - 1966; Non-thermal aerosols comparable in efficacy to HV thermal applications
 - 1968; Mount builds first ULV ground aerosol machine
 - 1969-72; Commercial ULV generators and technical formulations of insecticides manufactured

Ground ULV Adulticiding

“ULV is the application of the minimum effective volume of an undiluted formulation of insecticide in liquid form as received from the manufacturer.”

Gary A. Mount, USDA, Gainesville, FL (retired)



10 MPH

20 ft.

**ULV spraying fills a 20-foot column with an
ultra low volume of active ingredient**

Do we really have to
calibrate? Let's just spray!

The label is the law!!



BIOMIST® 3+15 ULV

For Use Outdoors as an Ultra-Low Volume (ULV) Application to Control Adult Mosquitoes in Residential and Recreational Areas. Also for use against Bling and Non-Bling Mosquitoes and Blackflies.

For use only by federal, state, tribal or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision.

ACTIVE INGREDIENTS	
Permethrin (3-phenoxyphenyl) methyl (+)-cis- trans-3-(2,2-dichloroethoxy)-2,2-dimethyl cyclopropanecarboxylate	3.0%
Piperonyl Butoxide*	15.0%
OTHER INGREDIENTS**	82.0%
	100.0%
Contains 0.222 pounds of Permethrin and 1.113 pounds of PBO per gallon	
*PBO: (butyl carboxyl) (5-propyl)peroxy ether and related compounds	
** Contains petroleum distillate	

KEEP OUT OF REACH OF CHILDREN CAUTION

FIRST AID	
Have product container or label with you when calling a poison control center or doctor, or going for treatment. For Medical Emergencies, call the International Poison Control Center at 1-800-214-7535.	
IF SWALLOWED:	Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not use anything to mouth to an unconscious person.
IF ON SKIN OR CLOTHING:	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
IF INHALED:	Move person to fresh air. If person is not breathing, call 911 for an ambulance, then give artificial respiration, preferably mouth-to-mouth. Call a poison control center or doctor for further treatment advice.
IF IN EYES:	Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing the eye. Call a poison control center or doctor for treatment advice.
NOTE TO PHYSICIAN: Product contains a petroleum distillate. Ventilation may cause aspiration pneumonia.	

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION: Harmful if swallowed or absorbed through skin. Avoid contact with skin, eyes or clothing. Avoid breathing spray mist.

Personal Protective Equipment (PPE): Some materials that are chemically resistant to this product are: barrier laminate, nitrile rubber, neoprene rubber, or viton. Mixers, loaders, applicators, and other handlers must wear long-sleeve shirt and long pants, shoes plus socks. In addition, all handlers except for applicators using meterized ground equipment, pilots and flaggers, must wear chemically-resistant gloves. In addition, mixer/loaders, persons cleaning equipment, and other persons exposed to the concentrate must wear a chemically-resistant apron. See engineering controls for additional requirements.

User Safety Requirements: Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with the product's concentrate. Do not reuse them.

Engineering Controls: Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides (80 CFR 170.240(a)(8)). Human flagging is prohibited. Flagging to suggest aerial application is limited to use of the Global Positioning System (GPS) and magnetic flagging.

USER SAFETY RECOMMENDATIONS: Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Users should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Users should remove PPE immediately after handling the product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This pesticide is extremely toxic to aquatic organisms, including fish and invertebrates. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Before making the first application in a season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, bays, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. Not for use in metered misting systems. Not for use in outdoor residential misting systems. Do not contaminate crop land (other than crop fields) or potable water supplies with spray drift. Do not make applications during rain.

USE INFORMATION

BIOMIST 3+15 ULV is approved for applications as an ultra-low volume (ULV) nonthermal aerosol cold fog to control adult mosquitoes in residential and recreational areas and other areas these insects occur, such as but not limited to parks, campuses, woodlands, athletic fields, golf courses, residential areas and municipalities, gardens, playgrounds, and overgrown waste areas.

BIOMIST 3+15 ULV can be applied over specific growing crops and range grasses prior to harvest for the control of adult mosquitoes within or adjacent to these areas. Application can be made where the following crops are present:

Alfalfa	Corn, grain	Chenopodium
Almond	Corn, driver	Chickpea
Apple	Corn, sweet, kernel + cob with husk removed	Chestnut
Artichoke	Eggplant	Citrus
Asparagus	Flax, grain, group 11	Cottonseed
Avocado	Grape	Cucurbit
Banana	Guava	Cucumber
Broadbean	Jackfruit	Custard apple
Broadbean sprout	Jackfruit	Custard apple
Cabbage	Leafy greens, subgroup 4B	Custard apple
Cauliflower	Leafy greens, subgroup 4A	Custard apple
Cherry	Letuce, head	Custard apple
Cherry	Mustard	Custard apple
Corn, flange		Custard apple

*All OF 180-A Crop Group 8 Crop Group 9 Crop Group 10 Crop Group 11 Crop Group 12 Crop Group 13 Crop Group 14 Crop Group 15 Crop Group 16 Crop Group 17 Crop Group 18 Crop Group 19 Crop Group 20 Crop Group 21 Crop Group 22 Crop Group 23 Crop Group 24 Crop Group 25 Crop Group 26 Crop Group 27 Crop Group 28 Crop Group 29 Crop Group 30 Crop Group 31 Crop Group 32 Crop Group 33 Crop Group 34 Crop Group 35 Crop Group 36 Crop Group 37 Crop Group 38 Crop Group 39 Crop Group 40 Crop Group 41 Crop Group 42 Crop Group 43 Crop Group 44 Crop Group 45 Crop Group 46 Crop Group 47 Crop Group 48 Crop Group 49 Crop Group 50 Crop Group 51 Crop Group 52 Crop Group 53 Crop Group 54 Crop Group 55 Crop Group 56 Crop Group 57 Crop Group 58 Crop Group 59 Crop Group 60 Crop Group 61 Crop Group 62 Crop Group 63 Crop Group 64 Crop Group 65 Crop Group 66 Crop Group 67 Crop Group 68 Crop Group 69 Crop Group 70 Crop Group 71 Crop Group 72 Crop Group 73 Crop Group 74 Crop Group 75 Crop Group 76 Crop Group 77 Crop 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DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

SPRAY DROPLET SIZE DETERMINATION

Ground-based Application: Spray equipment must be adjusted so that the volume median diameter (VMD) is less than 30 microns ($D_v 0.5 < 30 \mu m$) and that 90% of the spray is contained in droplets smaller than 50 microns ($D_v 0.9 < 50 \mu m$). Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. **Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.**

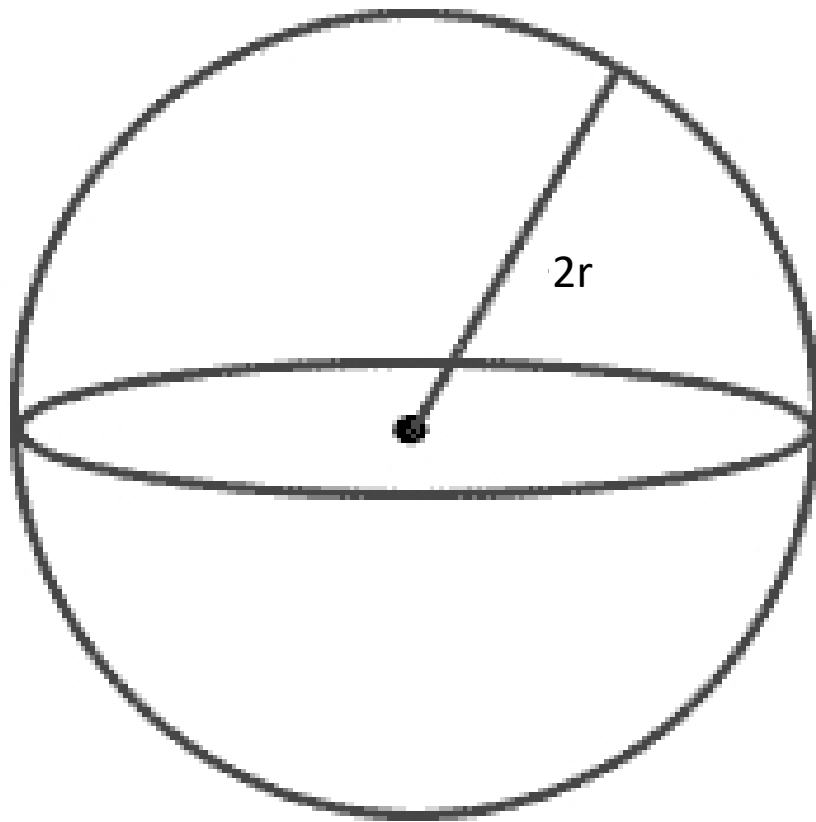
Why bother, let's just spray!

Pesticide labels require that ULV machines be calibrated annually

Just as important are efficacy and money.

Volume of a Sphere

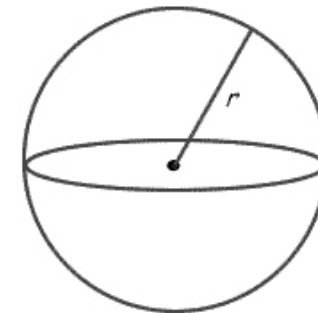
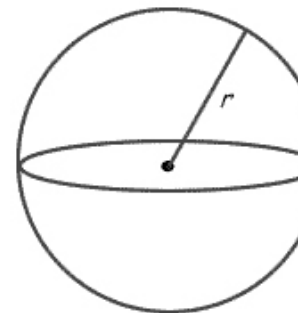
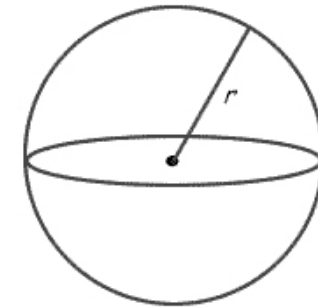
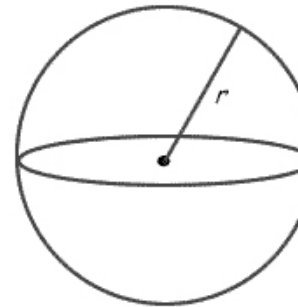
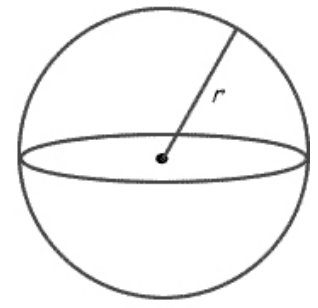
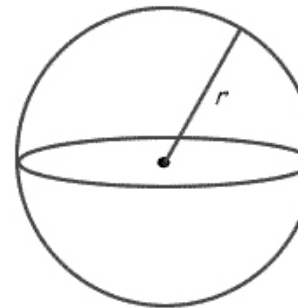
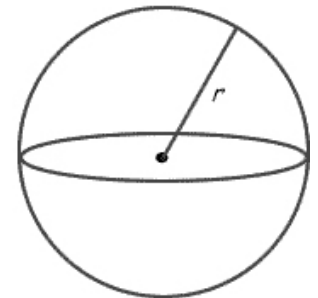
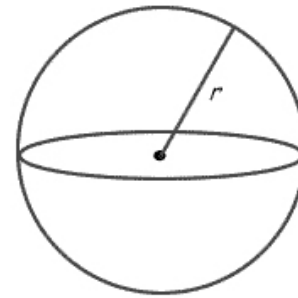
$$V = \frac{4}{3}\pi \bullet r^3$$

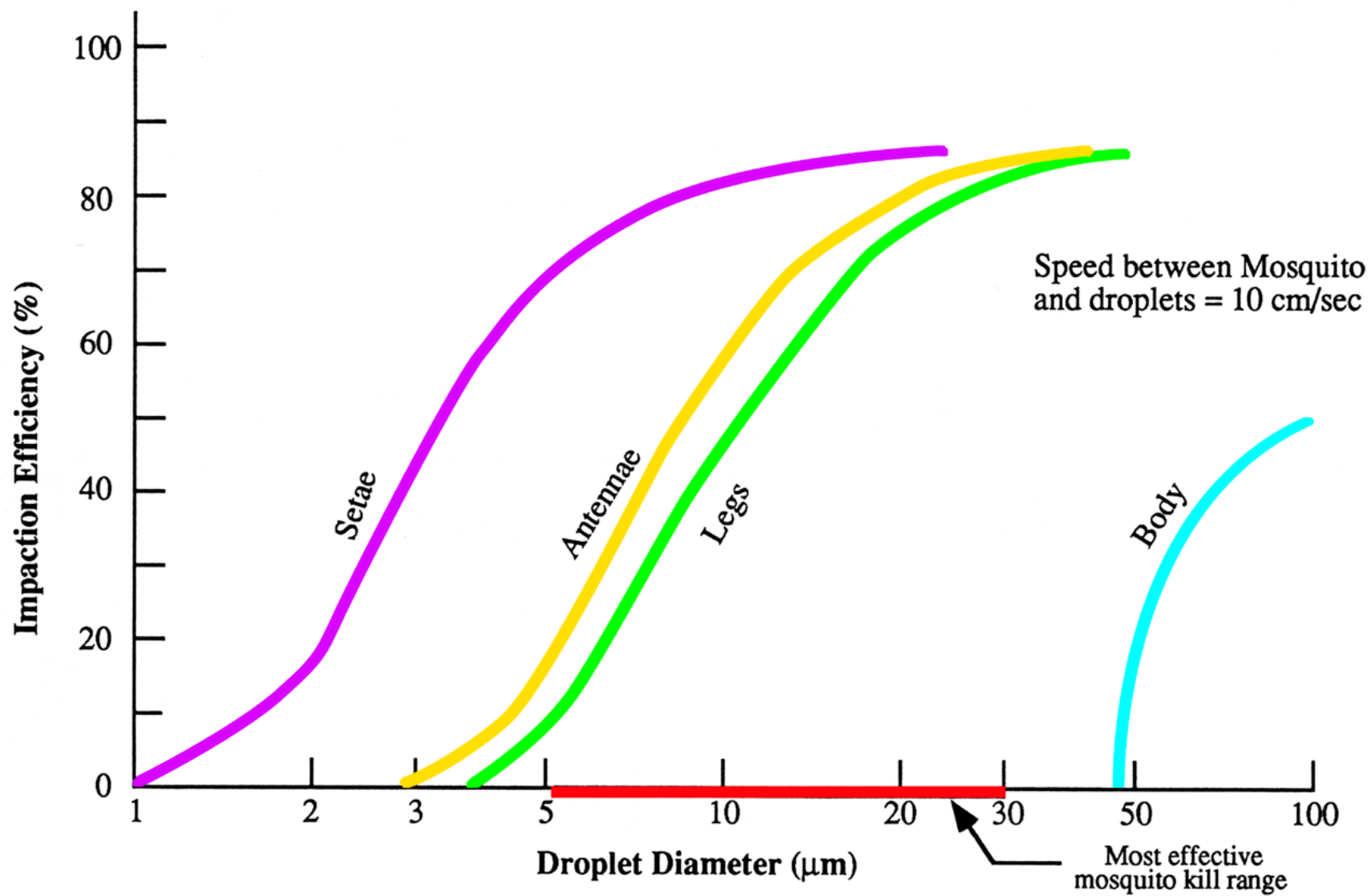


$$V_1 = \frac{4}{3} \pi (2r)^3 =$$

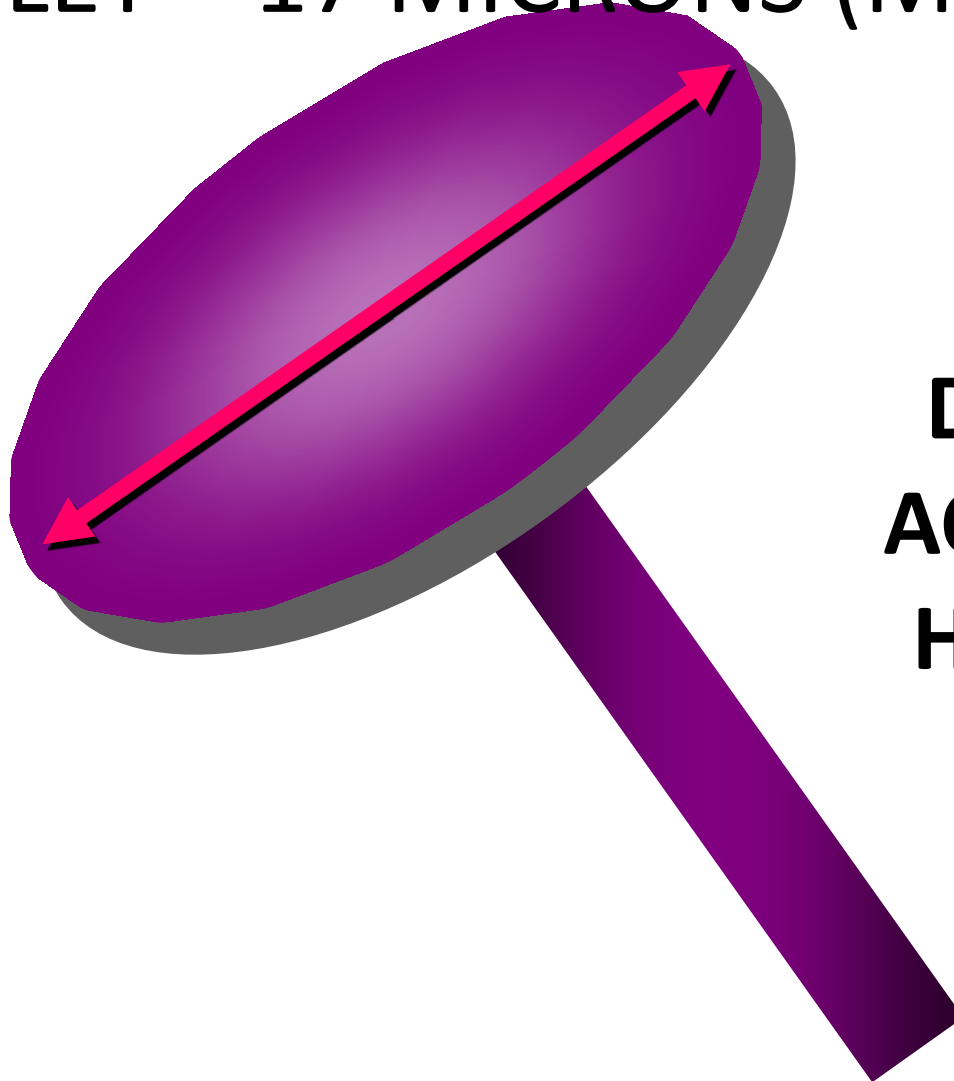
$$\frac{4}{3} \pi 2^3 r^3 = 8 * \frac{4}{3} \pi r^3$$

$$V_2 = \frac{4}{3} \pi r^3$$





ULV DROPLET = 17 MICRONS (MMD)

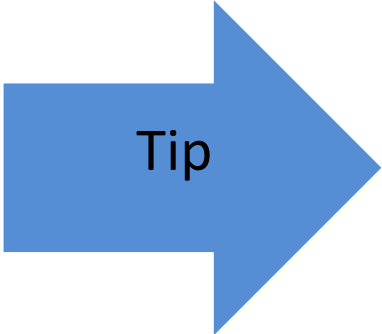


**150
DROPLETS
ACROSS THE
HEAD OF A
PIN**

ULV Machine Calibration

Calibration Factors ULV

- Determine vehicle speed (review label)
- Determine desired flow rate (lbs. active ingredient per acre)
- Verify insecticide flow (pump output)
 - **Time insecticide flow for 1 minute (lab pump standard flow control)**
 - **Draw from a known quantity (Badger)**
 - **Synchronize pump to flow control system (Clarke SmartFlow)**



Tip

To help maximize your budget:

Implement monthly calibration to insure precise application

GROUND APPLICATION

Apply BIOMIST 3+15 ULV through standard ULV cold aerosol or non-thermal aerosol (Cold Fog) generators undiluted at a flow rate of 3.1 to 17.4 fluid ounces per minute, and an average vehicle speed of 10 MPH. If a different vehicle speed is used, adjust rate accordingly. These rates are equivalent to 0.00088 to 0.005 pounds of Permethrin and 0.0044 to 0.025 pounds of PBO per acre. An accurate flow meter must be used to ensure the proper flow rates. Vary flow rate according to vegetation density and mosquito population. Use higher flow rate in heavy vegetation or when populations are high.

Permethrin/PBO Pounds per Acre	Application Rates Fl.oz./Minute				Fl.oz. BIOMIST 3+15 ULV per Acre
	5 MPH	10 MPH	15 MPH	20 MPH	
0.005/0.025	8.7	17.4	26.1	34.9	2.88
0.0025/0.0125	4.4	8.7	13.1	17.4	1.44
0.00088/0.0044	1.5	3.1	4.6	6.1	0.51

Failure to follow the above directions may result in reduced effectiveness..

Determining Flow Rate

SWATH x SPEED

----- = ACRES/MIN

495

Acres/min x Oz/Acre = Oz/Min calibration flow rate

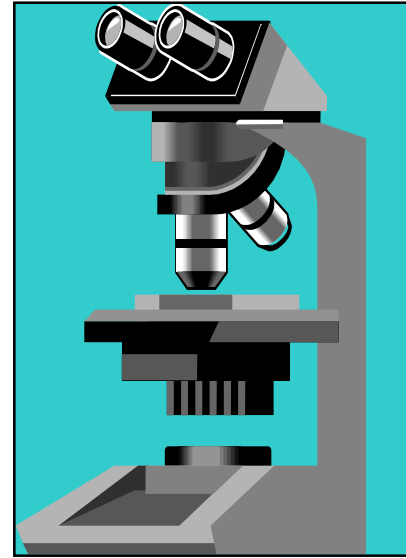


Droplet Analysis

- Slide collection
- AIMS Unit
 - **Most commonly used field method for ground ULV machines**

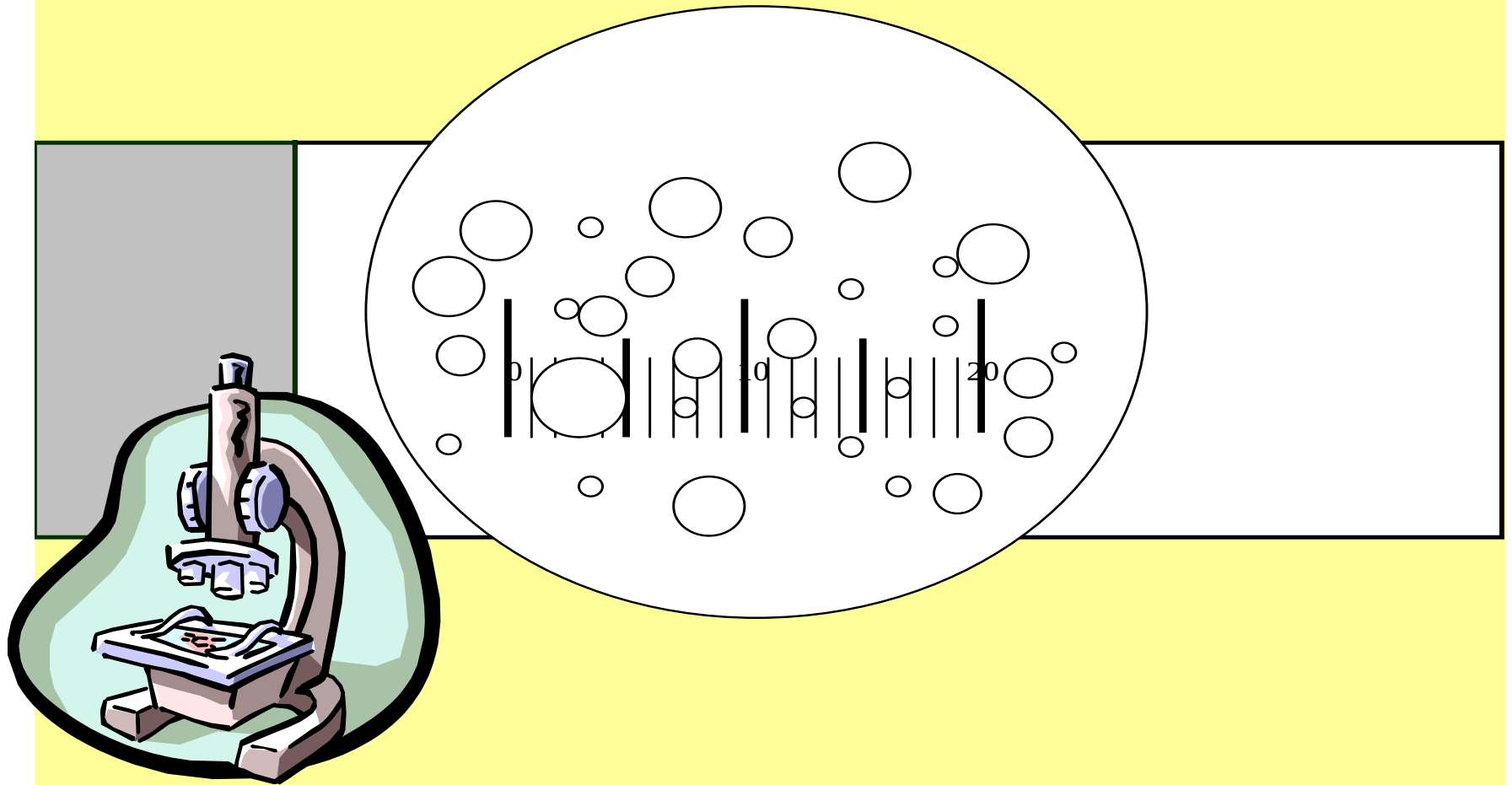
Microscope Calibration

- **Compound** microscope with mechanical stage and an ocular micrometer
 - **Ocular micrometer ruled in a scale of 100 divisions**
 - **Stage micrometer with calibration scale usually one millimeter (mm) long and usually ruled in large (0.1) and small (0.01) increments**



DROPLET MEASUREMENT DIAGRAM

Measure every droplet that passes through the micrometer.

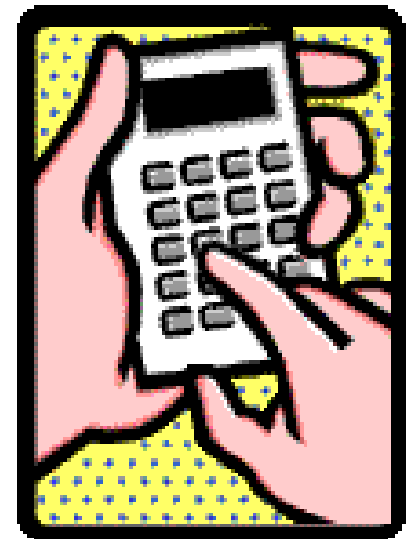


Example of droplet analysis determining accumulative percent of total volume for each droplet size.

Eye-piece Division (D)	No. of droplets (N)	No. of droplets times divisions (DXN)	Percent of total volume ($DXN \div \sum DXN$)	Accumulative percent of total volume
1	1	1	.05	.05
2	8	16	.78	.83
3	11	33	1.62	2.45
4	16	64	3.14	5.59
5	11	55	2.70	8.29
6	21	126	6.18	14.47
7	19	133	6.53	21.00
8	58	464	22.79	43.79
9	22	198	9.72	53.51
10	36	360	17.68	71.19
11	24	264	12.97	84.16
12	12	144	7.07	91.23
13	8	104	5.11	96.34
14	1	14	.69	97.03
15	4	60	2.94	99.97
Total	252	2036		

Measurements taken at 400x magnification. Spread factor is .59

Each Eye-piece division = 1.44 microns (2.45 X .59 spread factor)



DC – IV (AIMS)

- DC - IV
- Install software into laptop computer (IBM compatible)
- Connect DC-IV to power source and to measuring probe
- Go into setup screen and set following parameters:
- Max Time = 30 seconds
- Max Drops = 10,000 droplets
- Liquid = Oil
- Determine the test location by measuring a spray velocity of 5-7 m/s.
- From approximately eight feet from spray nozzle, sample the velocity using the velocity button on the screen. Move closer, in one-foot intervals, until the desired velocity is achieved. (Usually 4-6 feet)
- With measuring probe ring perpendicular to the spray nozzle and centered in the spray, Begin testing. Repeat test at least twice.
- *Clean probes after each use with a 50% acetone/50% xyline solution and rinse with distilled water.*
- *Handle probes very gently and NEVER touch the wire ring or sensing wire.*

DC - IV



DC-IV Connections



Certified Probes



DC – IV Probe



DC – IV LRT

Little Round Thing



1" PVC Pipe

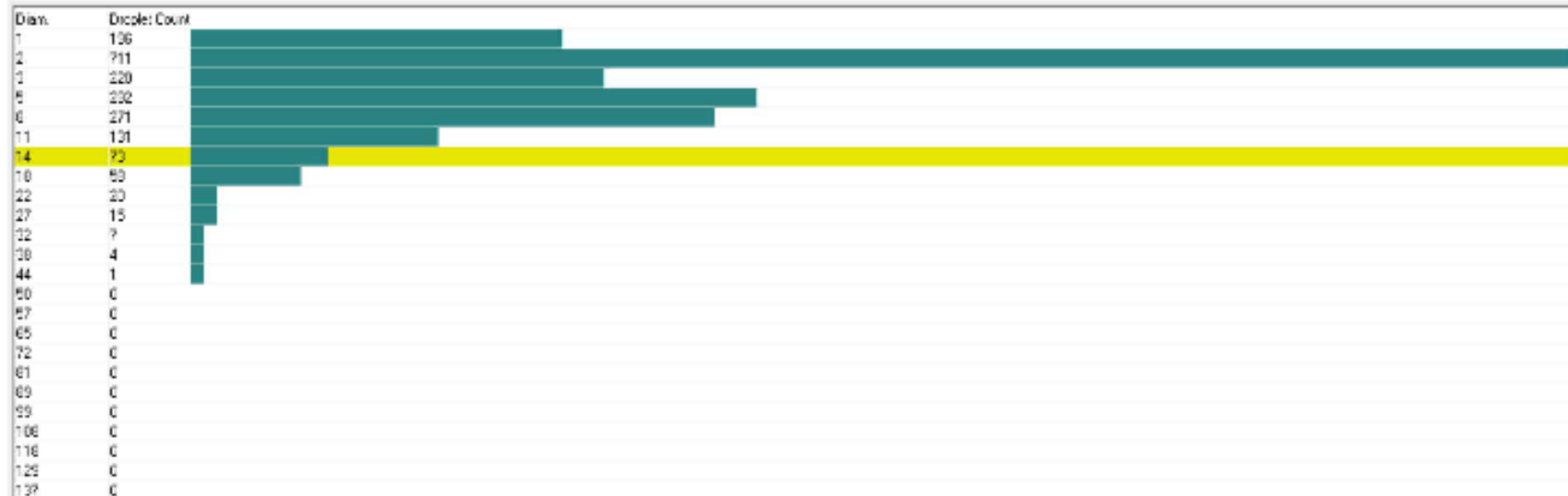
Thingerjinger





Mass (Volume) Median Diameter: 14.24 microns

Timeout	20	Sauter Mean: 9.48	D90: 31.09	Collection Time: 20.00
Red	> 400	Volume Mean: 4.71	D10: 4.00	Counts: 32.7
Yellow	< 200	Area Mean: 3.00	Span (D90 - D10)/MMD: 1.00	Counts: 40.0
Droplet Type	08	Number Mean: 2.45	Number Median: 2.45	Total Count: 1365
Droplet Size	2000	Mass Median: 14.24	MMD / MMD: 0.17	Min/Max Diameter: 1.35



Collected By: jpk@house	Sprayer Type: Phoenix 500 LD	Distance to probe: 5 ft	Weather: overcast
Test Number: 2	Sprayer ID: 405	R.P.M.: 2800	Humidity: low
Date - Time: Wed May 30 11:19:32 2018	Product: Biochem 1.5x7.5	Flow: 5.02/min	Wind Speed: 0 ft
Customer Name: Dallas GA	Formulation:	Pressure: 30 psi	Ambient Temperature: 74
Product Temp: 74	Diluent:		

In Summary

- Development of ULV adulticiding is relatively new to insecticide application technology
- Knowledge of adult mosquito behavior is critical to successful timing of a ground adulticide application
- Environment; meteorology and habitat set the parameters of how a ground adulticide application will be made