



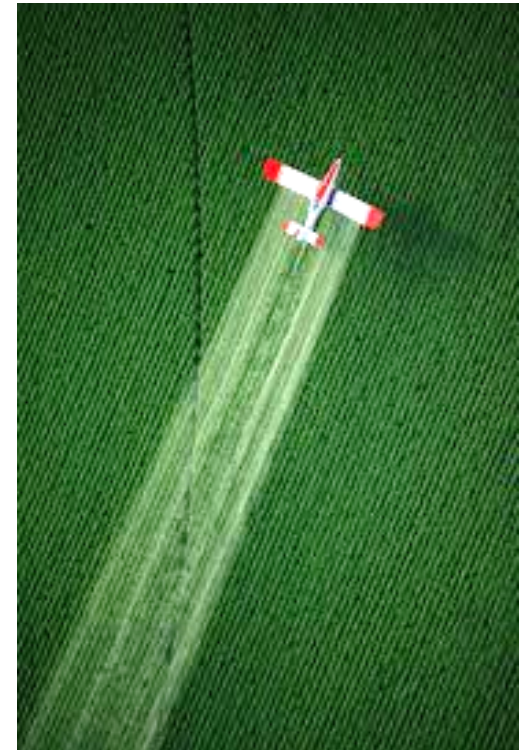
STRENGTHENING MARKETS THROUGH FORMULATION, APPLICATION AND EVALUATION TECHNOLOGY

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LAM INTERNATIONAL CORP



KEY CONSIDERATIONS FOR ADOPTION OF BIOPESTICIDES FOR PEST CONTROL

- GROWER/PCA AG MIND SET
- BIOLOGY / LIFE CYCLE / HABITS OF PEST
- CROP – CANOPY
- WATER VOLUME
- ACTIVE INGREDIENT PER DROPLET
- PRODUCT FORMULATION
- SPRAY EQUIPMENT / APPLICATION
- EFFICACY / EVALUATION
- NICHE MARKET EXAMPLES





GROWER / PCA/AG MIND SET

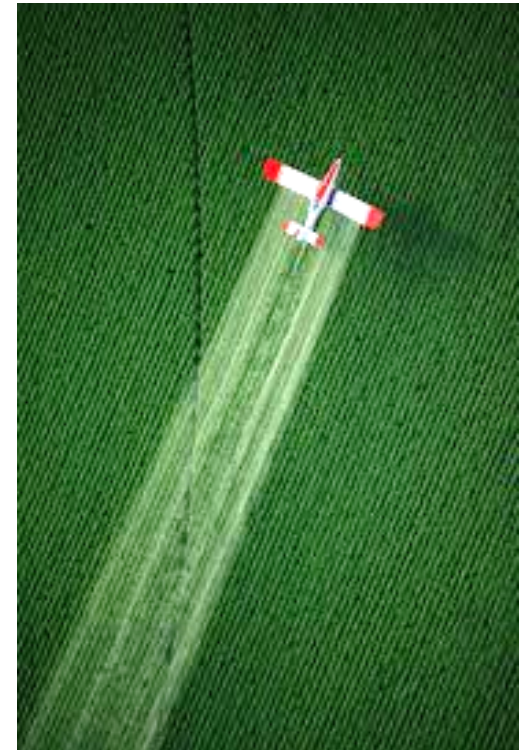
- PESTS - PROBLEMS - PRODUCTS
- WANTS AND NEEDS
 - EFFICACY – KNOCKDOWN / FAST RESULTS
 - EASY-TO-USE FORMULATIONS
 - IN-TANK MIX COMPATIBILITY
 - LOW COST
- PARADIGMS – BARRIERS FOR ADOPTION OF BIOLOGICALS
 - THOUGHT TO BE: PREVENTIVE, SHORT-LIVED, LOW SPECTRUM, LOW EFFICACY, SLOW ACTING, INCOMPATIBLE IN-TANK MIX, REFRIGERATED STORAGE, ADDITIONAL COADJUVANTS NEEDED, ENVIRONMENTAL CONDITIONS (HUMIDITY- TEMPERATURE-TIME OF APPLICATION), HIGH COST, “ACTIVATION” NEEDED, SNAKE OIL.





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BIOLOGY / LIFE CYCLE / HABITS

- INSECT PEST

- LEAF-EATING INSECTS

- LEPIDOPTERA, COLEOPTERA, ORTHOPTERA

- MOSTLY “EXPOSED” – **INGESTION & CONTACT** BIOPESTICIDES

- **SUCKING**

- HEMIPTERA, THYSANOPTERA, ACARI

- HEMIPTERA: Aphids, Whiteflies, Scale Insects, Mealy bugs, Psyllids, Plant Hoppers

- THYSANOPTERA: Thrips

- ACARI: Mites

- MOSTLY “HIDDEN” – **CONTACT** BIOPESTICIDES



KNOWLEDGE – KNOW YOUR PEST



BIOLOGY / LIFE CYCLE / HABITS

LIFE CYCLE STAGES OF SUCKING PESTS

- ACARI: SPIDER MITES
 - Egg - larval - nymph (protonymph & deutonymph) – adult
- THYSANOPTERA: THRIPS
 - Egg – larvae – prepupa - pupa - adult
- HEMIPTERA suborder Sternorrhyncha: APHIDS, WHITEFLIES, SCALE INSECTS AND MEALY BUGS
 - Usually Egg - several nymph - adult (some have prepupa and pupa stages).
 - Some groups are ovoviviparous: eggs hatch inside female, and young are born live.



ALL OF THE ABOVE HAVE MOBILE BUT MAINLY SESSILE STAGES



BIOLOGY / LIFE CYCLE / HABITS

PEST LOCALIZATION

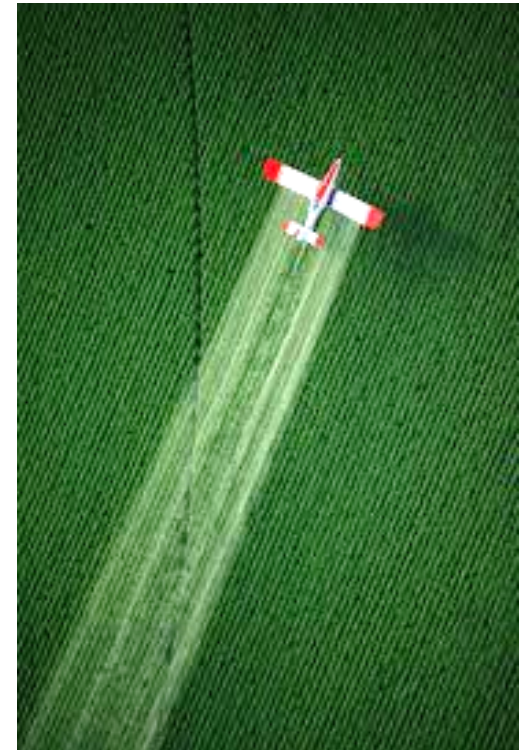
- SPIDER MITES
 - ALL STAGES – Upper 1/3
- APHIDS & THRIPS
 - LARVAL AND ADULT – New terminals and flowers
 - THRIP PREPUPA & PUPA – Ground/soil
- WHITEFLIES
 - EGGS – Upper 1/3
 - NYMPHS STAGES I, II & III – Middle 1/3
 - NYMPH STAGE IV & PUPA – Lower 1/3





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CROP CANOPY

- Assessment of the density of foliage in the canopy is needed.
- One hectare is 10,000 sq. meters (1 ha = 2.2 acres).
If rows are 6m apart, trees 4m high, and 3m wide:
 - the length of row is $10,000\text{m}/6 = 1,667\text{m}$
 - $1,667\text{m} \times 4\text{m} \times 3\text{m} = 20,000 \text{ m}^3$ of foliage per hectare
(5,469ft x 13.1ft x 9.8ft)/2.2 = 319,141 ft³/acre
- Spray volume required for volume of foliage will be 10 to 100 liters (2.5 to 25 gal) per 1,000m³
 - If we select 50 liters (12.5 gal), the volume of application rate is $20,000\text{m}^3 \times 50/1000 = 1000 \text{ liters/ha}$
- 250 gallons/ha (Approx. 110 gal/acre)

WATER USE IS BECOMING MORE CRITICAL





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WATER VOLUME

SOUTH AMERICA GAL/ACRE

- ORNAMENTALS: 100 - 140
- SOYBEAN/COTTON: 6 – 22
- CITRUS: 70 – 150
- TOMATO/BERRIES: 45 – 115

NORTH AMERICA GAL/ACRE

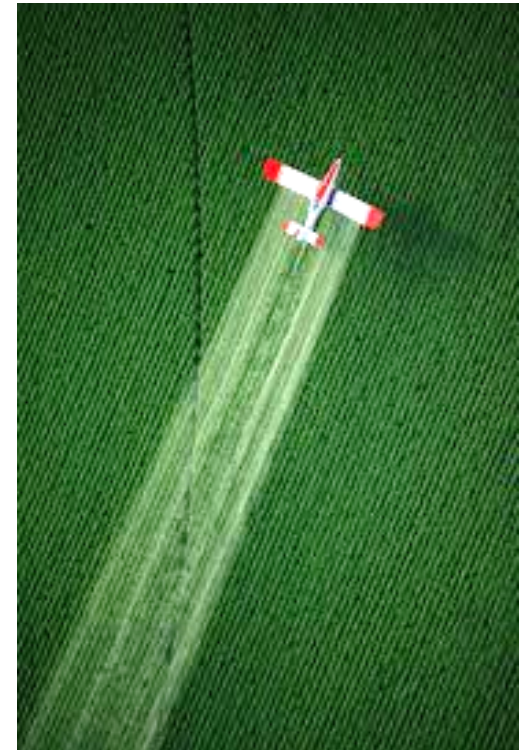
- ORNAMENTAL: 200 – 450
- SOYBEAN/COTTON: 6 - 22
- CITRUS: 230 – 600
- TOMATO/BERRIES: 45 – 230





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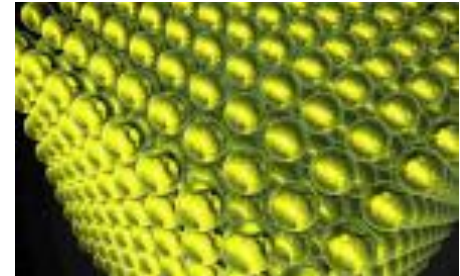




ACTIVE INGREDIENT PER DROPLET

Beauveria example

- Optimum **1 x 10e7 spores/ml** final concentration (10 million spores per ml) for good coverage and efficacy.
 - For 400 lts of water: **4 x 10e12 spores**
 - For 1000 lts of water: **1 x 10e13 spores**
 - For 2000 lts of water: **2 x 10e13 spores**
- 1 ml of spray solution generates approximately 30,300 – 200 micron droplets or 242,400 – 100 micron droplets.
- A **200 micron** droplet contains **330 spores**.
- A **100 micron** droplet contains **40 spores**.
- What if 10X, 100x or 1,000x less spore content?





ACTIVE INGREDIENT PER DROPLET DROPLET AREA COVERAGE

Droplet Size	/square in.	/square mm
• 100 micron	1,150	1.78
• 150 micron	342	0.53
• 200 micron	144	0.22

1 square inch = 6.45 square cm = 645 square mm

Whitefly (*Bemisia tabaci*) 270 spores/square mm

Journal of Invertebrate Pathology 71, 217–226 (1998)

Adult: 0.8 mm in length

Egg: 0.25 mm in length

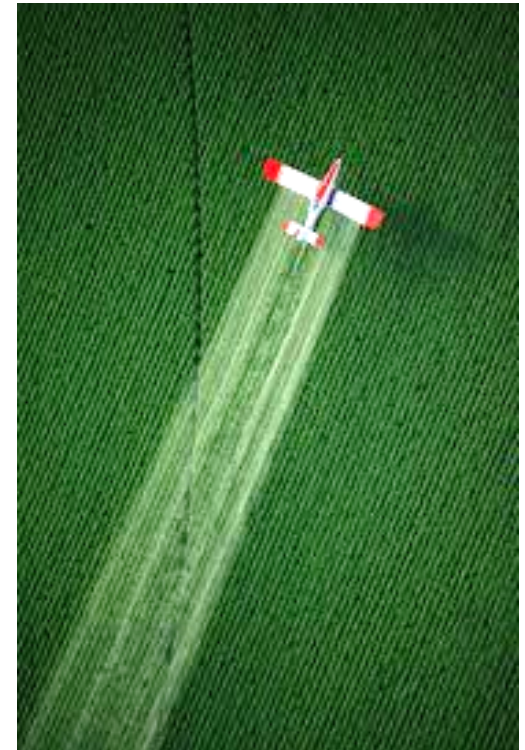
Nymph: 1st instar, 0.3 mm & 4th instar, 0.6 mm in length





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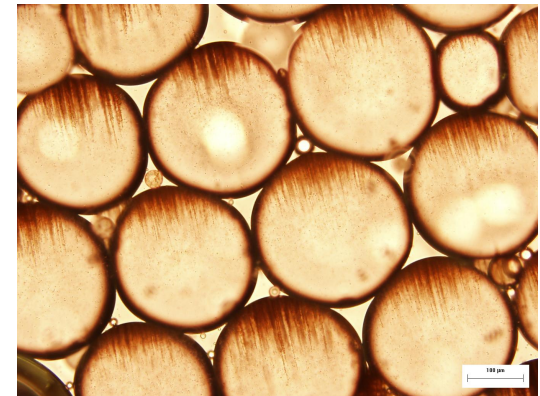




PRODUCT FORMULATION

IDEAL FORMULATION

- HIGH (SUFFICIENT) A.I. CONTENT
 - BIOEFFICACY
- PROTECT A.I. FROM DEGRADING
- NO REFRIGERATION
- EXTENDED SHELF-LIFE
- EMULSIFIABLE
- IN-TANK MIX COMPATIBLE WITH CHEMISTRIES
- RAINFAST (ATTACH TO LEAF SURFACE, INSECT CUTICLE)





PRODUCT FORMULATION

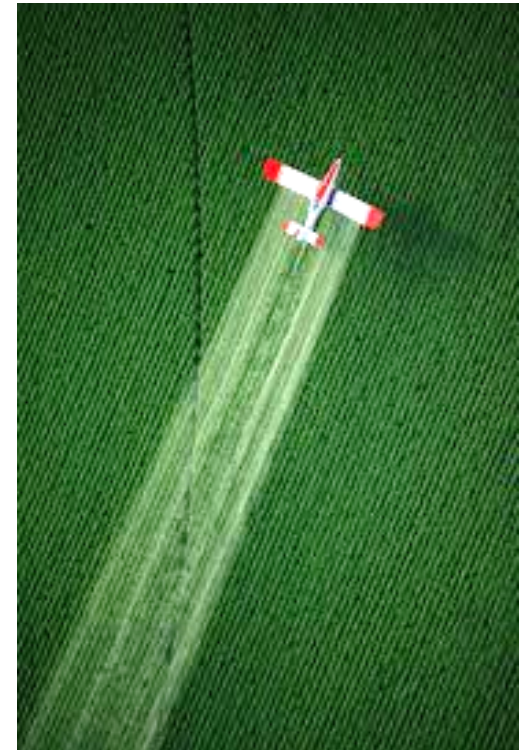
- OIL BASED
 - W/O vs O/W EMULSIONS
 - Hydrophilic-Lipophilic Balance (HLB)
 - IN TANK MIX WITH CHEMISTRIES
- WETTABLE POWDERS
 - EMULSIFIABLE
 - NOT CLOG NOZZLES
- DISPERSABLE GRANULES
 - SOIL APPLICATIONS





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SPRAY EQUIPMENT / APPLICATION

EFFICIENCY

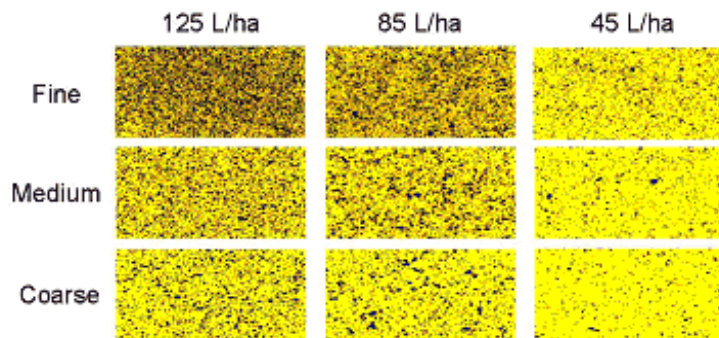
- Electrostatic (ESS)
- Foggers
- Motorized tractor sprayers
- Motorized back-pack
- Helicopter
- Airplane
- Manual sprayer





SPRAY EQUIPMENT / APPLICATION

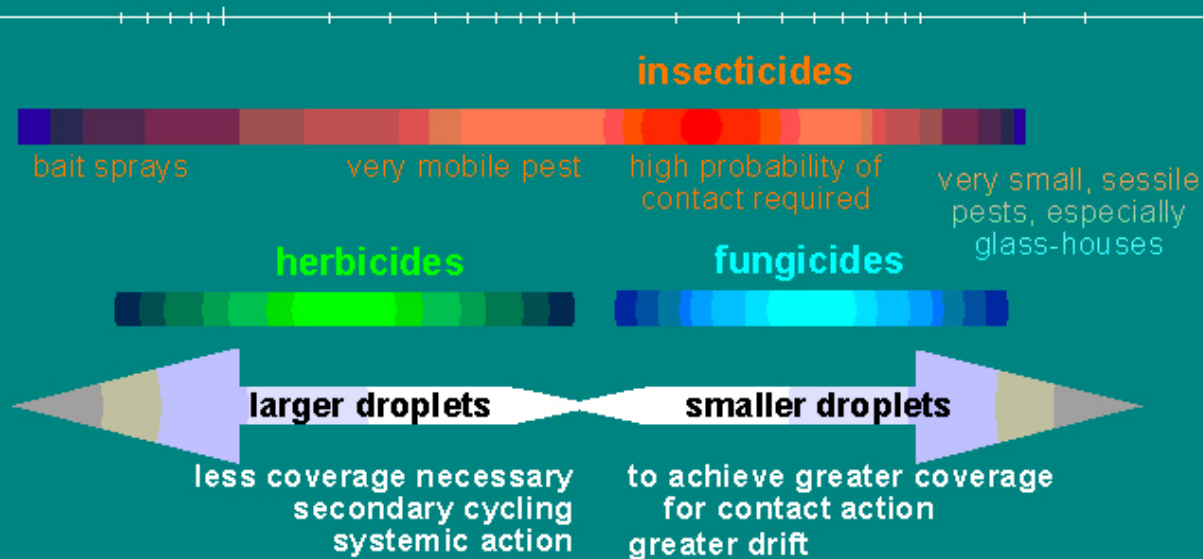
- COMPLETE SPRAY COVERAGE, SPECIALLY REACHING LEAF UNDERSIDE (ABAXIAL SURFACE)
- NOZZLE TYPE – DROPLET SIZE
- CONSTANT PRESSURE
- GENERATE TURBULENCE





A guide to spray droplet "coverage"

desirable deposition in the target zone - based on chance encounter with the target
droplets . cm⁻² 1 10 100



Note: (1) for guidance only - no substitute for field evaluation

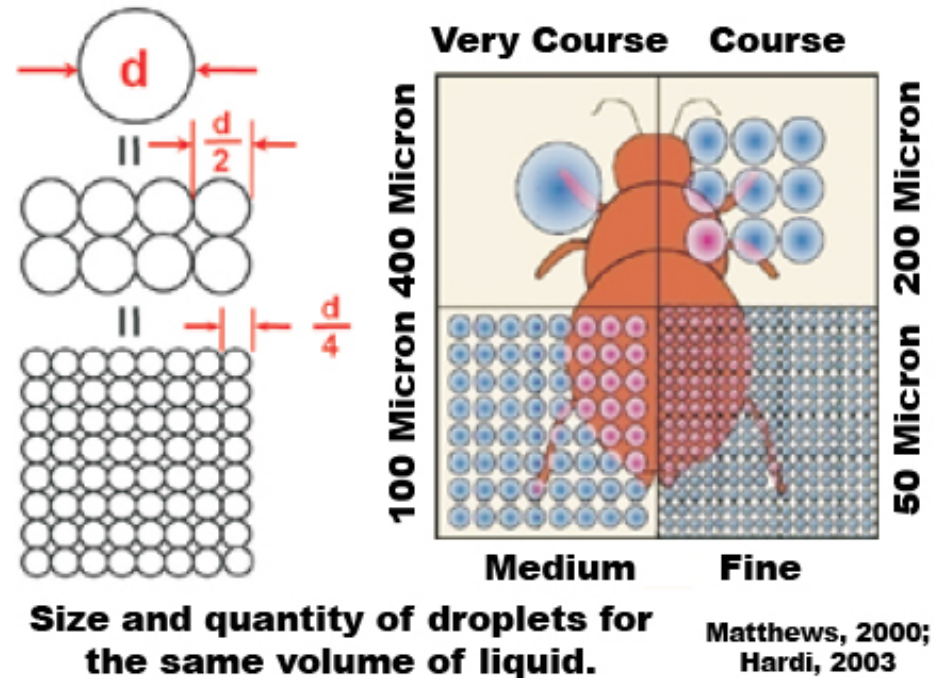
(2) no reference made to droplet: size, spreading, or a.i. concentration



SPRAY EQUIPMENT / APPLICATION

CONTROLLING DROPLET SIZE

- Avoid Drift
 - Water Volume
 - Spray Equipment
 - Nozzle Type
- Select nozzles and conditions to have droplets between 100 and 200 micron










SPRAY EQUIPMENT / APPLICATION

NOZZLE SELECTION

- Nozzles are the most important part of a sprayer.

Band and Direct Spraying				
				
Even Flat Fan	Twin Even Flat Fan	Hollow Cone	Full Cone	Disc and Core Cone
	Very Good	Very Good		Very Good





SPRAY EQUIPMENT / APPLICATION

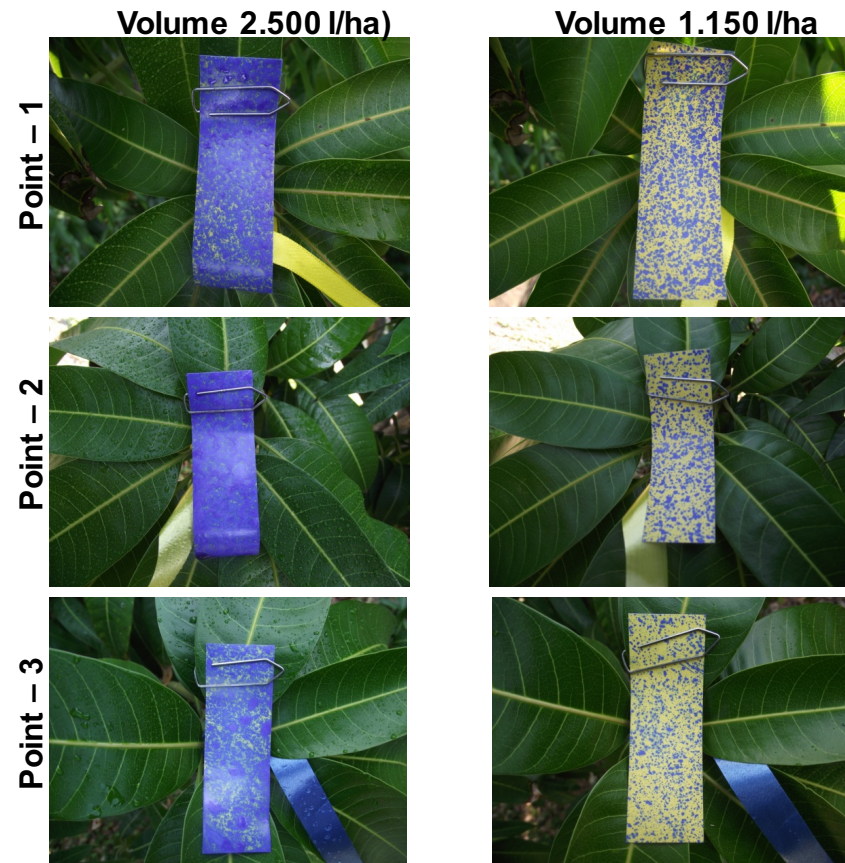




SPRAY EQUIPMENT / APPLICATION

APPLICATION EFFICIENCY

- Using the correct water volume will save a significant amount of time and money.





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EFFICACY / EVALUATION

- Evaluation based on cease of damage or pest presence.
- Evaluate at 72 – 96 hours after application.
- Use of “new” Technological Gadgets.
 - Demonstrate efficacy of application
 - Show pathogenic effects on insects
 - e.g. Proscope hand held devices or similar



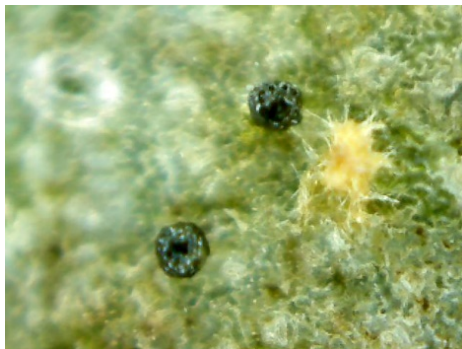
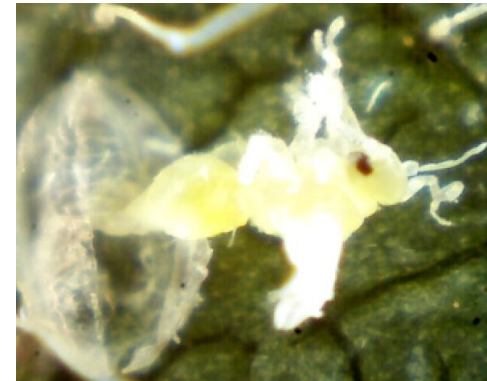


EFFICACY / EVALUATION





EFFICACY / EVALUATION





EFFICACY / EVALUATION

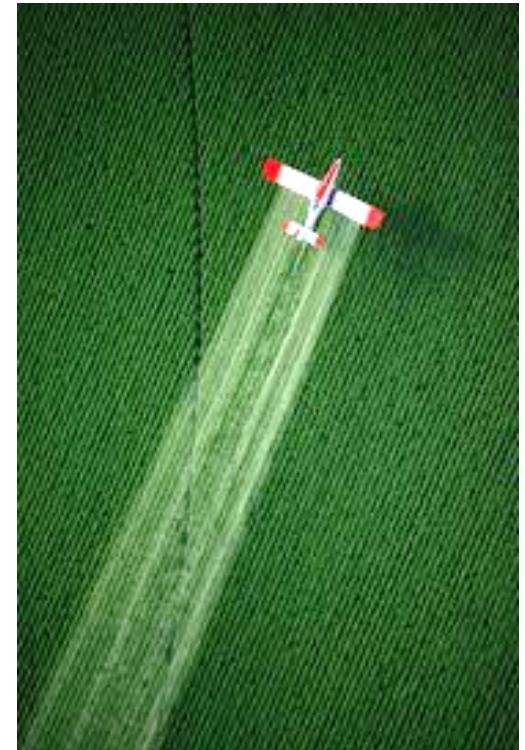
- SPORULATION IS NOT A MEASURE OF CONTROL.





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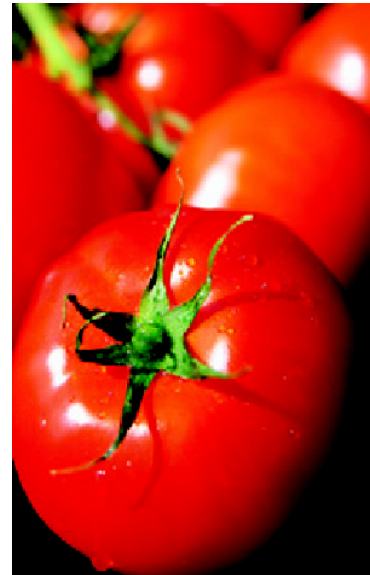
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NICHE MARKET EXAMPLES

- MAIN MARKETS
 - PROTECTED
 - GLASSHOUSE-GREENHOUSE
 - ORGANIC/HIGH VALUE
 - VEGETABLES
 - BERRIES





COFFEE

- COFFEE BERRY BORER
 - COMPLEX LIFE CYCLE
 - ADULTS, EGG, LARVAE
 - “HIDDEN PEST”
 - APPLICATION PROGRAM
 - LIMITED PRODUCTS





AVOCADOS

- THRIPS

- LIFE CYCLE

- LEAF (ADULT & LARVAE)

- GROUND (PREPUPA & PUPA)

- APPLICATION – TREE & SOIL

- LIMITED PRODUCTS





OIL PALM

- LEPIDOPTERA & COLEOPTERA
 - POLLINATOR PROTECTION
 - FAVORABLE ENVIRONMENT
 - HUMIDITY
 - LONG BTK HISTORY





RICE

- MULTIPLE PESTS
 - SPODOPTERA L1 & TAGOSODES (VIRUS)
 - INDIRECT EFFECTS
 - MOSQUITO CONTROL
- FAVORABLE ENVIRONMENTAL CONDITIONS
 - HUMIDITY / BENEFICIALS





COTTON

- WHITEFLY
 - EGG, NYMPH, ADULT
- HISTORY OF RESISTANCE ISSUES
- BT COTTON
- COMPETITIVE APPLICATION RATES
 - 125 ml/ha





SOYBEAN

- MULTIPLE TARGET PESTS
 - CHRYSOMELIDS, WHITEFLY & CHINCH BUGS
- EARLY CROP APPLICATIONS
 - <45 DAYS
- COMPETITIVE APPLICATION RATES
 - 125 ml/ha





CITRUS

- CITRUS PSYLLID
 - EGGS & NYMPHS
 - BIOEFFICACY TESTS
 - >30% Eggs
 - >100% Nymphs
 - CURRENTLY UNDER FIELD TESTS
 - COLOMBIA
 - BRAZIL



THANK YOU

