The Role of Bactericides in Huanglongbing Management

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CRDF Bactericide program

- What are the goals of this program?
- How do we try to achieve these goals?

Less of this

More of this

How to Help Citrus Growers

Soon?

Resistance

Tolerance

What the growers need *now*

- Keep trees in production
  - Slow the decline of infected trees
  - Improve fruit quality
  - Protect replants
- How?

CRDF Bactericide Program

Goal – get effective bactericides to growers

- First step - identification of potential bactericides
  - R & D Libraries
    - Agricultural Chemical Companies
    - Pharmaceutical Companies
  - Other Industries
  - Researchers
  - Agricultural Chemicals (Labeled for other crops)

CRDF Bactericide Discovery

- What have we been looking at?
  - More than 1000 chemicals tested *in vitro*
    - Antibiotics
    - Nanomaterials
    - New molecular entities
    - Minimum risk
    - Biopesticides
    - Agricultural chemicals

- How to prioritize?

Bactericide Discovery

- Average development of a new active is 11.3 years

Panel of studies:
- Ecological Risk Assessment
- Human Health Risk Assessment

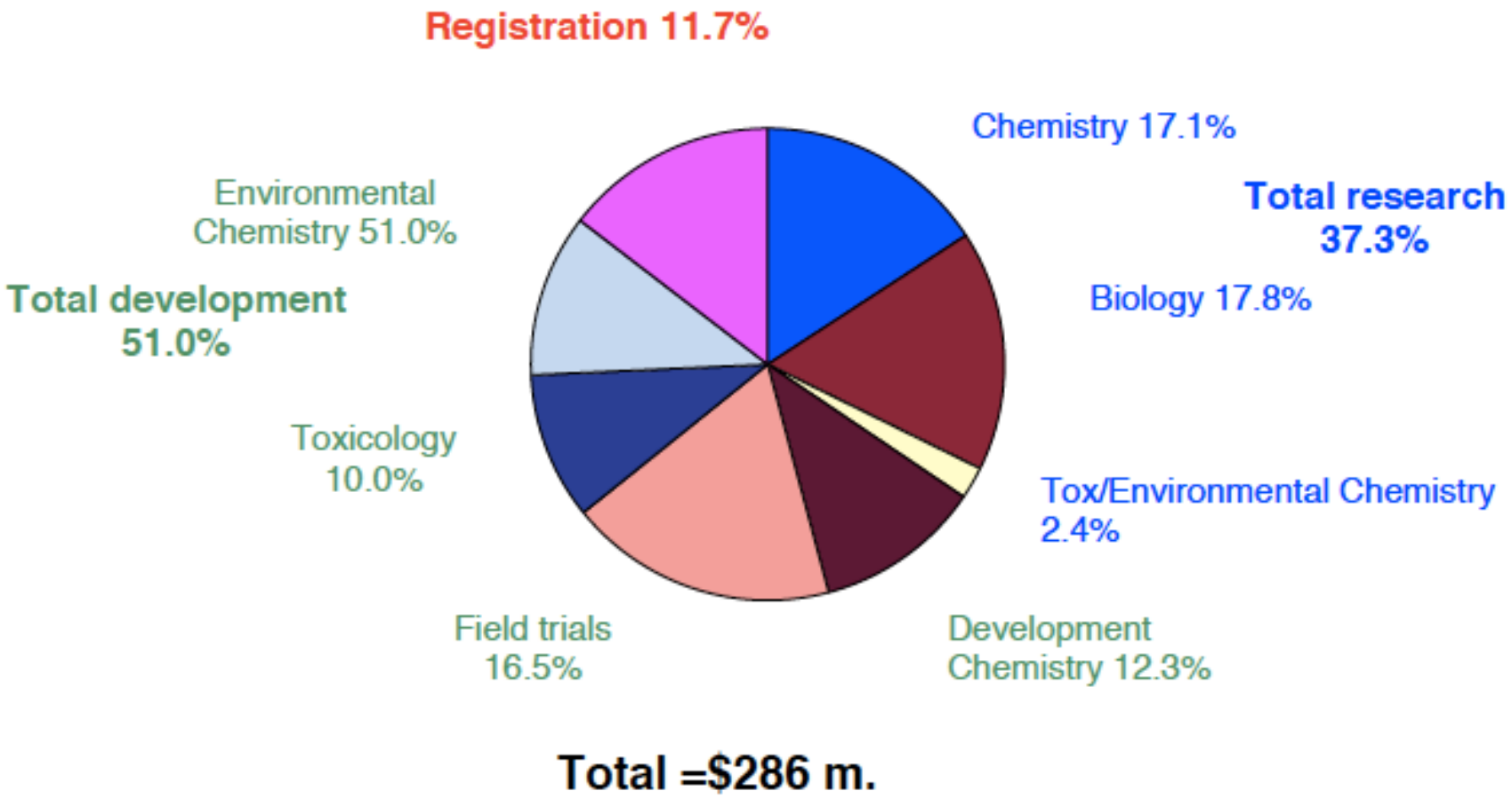
New MOAs may take longer than known chemical families

Required residue trials for Citrus Subgroup:
- 12 trials in Region 3 (FL)
- 2 in Region 6 (TX)
- 9 in Region 10 (CA)

- CLA/ECPA report on "The Cost of New Agrochemical Product Discovery, Development and Registration in 1995, 2000, 2005-8 and 2010 to 2014. R&D expenditure in 2014 and expectations for 2019 ". March 2016

Bactericide Discovery

2010-14



Total =$286 m.

- CLA/ECPA report on "The Cost of New Agrochemical Product Discovery, Development and Registration in 1995, 2000, 2005-8 and 2010 to 2014. R&D expenditure in 2014 and expectations for 2019 ". March 2016

Bactericide Discovery

- First step in the bactericide discovery process
  - What works in the petri plate?
  - More than 1000 chemicals tested
    - Antibiotics
    - Nanomaterials
    - New molecular entities
    - Minimum risk
    - Biopesticides
    - Agricultural chemicals
  - Near-term therapies needed
  - Next-generation bactericides are also important

Bactericide Discovery

Some bactericides are easier to register

- **Biopesticide**
  - Derived from natural materials such as animals, plants, bacteria, and certain minerals.
  - Considered reduced risk pesticides
  - May require a significantly reduced data set compared to conventional registrations.
  - Registration time and fees
    - Biopesticide = 19 months and $48,621
    - Conventional Pesticide = 24 months and over $590,000

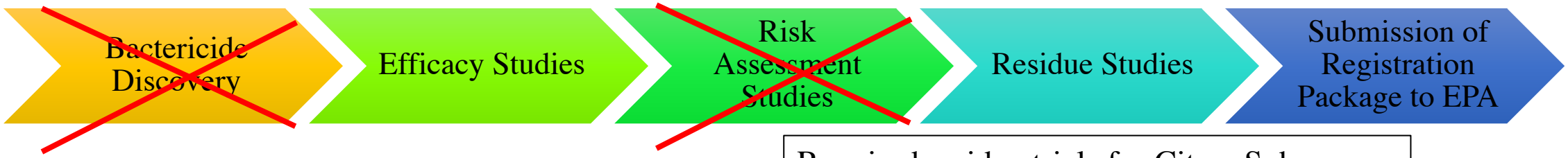
Minimum-Risk

- Exempt from registration under FIFRA section 25(b)
- Exempt Ingredients, both active and inert, are demonstrably safe for the intended use

Bactericide Discovery

- Labeled pesticides are a good solution
  - Time-to-market ~ 3 years
- Streptomycin and OTC

~ 1 year plus 24 month PRIA timeline (EPA)



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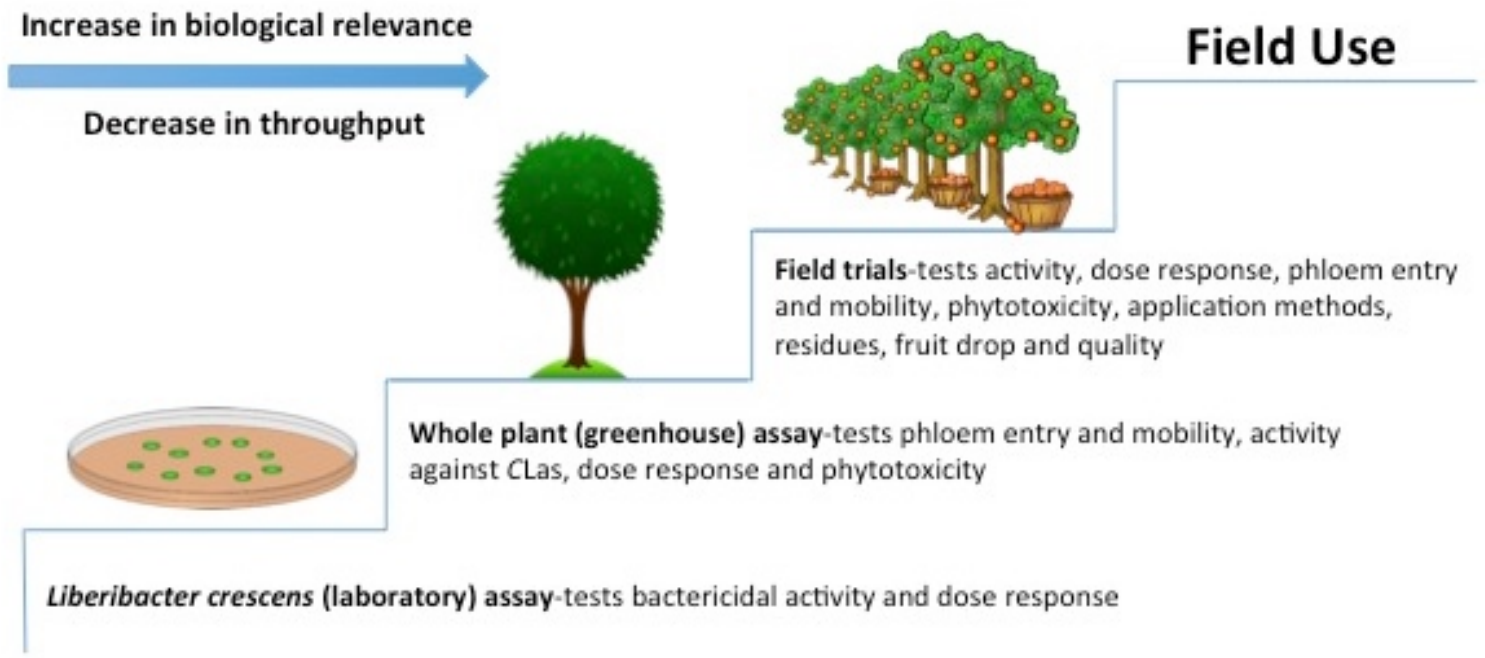
Bactericide Evaluations

- How do we test materials
  - Assay system



- Several field trials are in place to test bactericides

Bactericide Evaluation

Biopesticide Trial

- All botanical oil products
  - Thyme Guard (Agro Research International)
  - Ecotrol Plus (Keyplex)
  - Onguard EO (AgXplore)
  - Xplode (AgXplore)
  - Research EO
- Company application recommendations/adjuvants (foliar)
- Applications every 60 days

Bactericide Evaluation

Biopesticide Trial

- Two nearby blocks
  - One with no HLB detected
  - One 100% HLB detection

- Evaluations
  - Disease severity
  - Bacterial titer
  - Growth measurements
  - Leaf Nutrition
  - Canker
  - Fruit Drop
  - Yield

- After one year: no significant improvement in any treatment at either site

Bactericide Evaluations

Grower Bactericide Trials

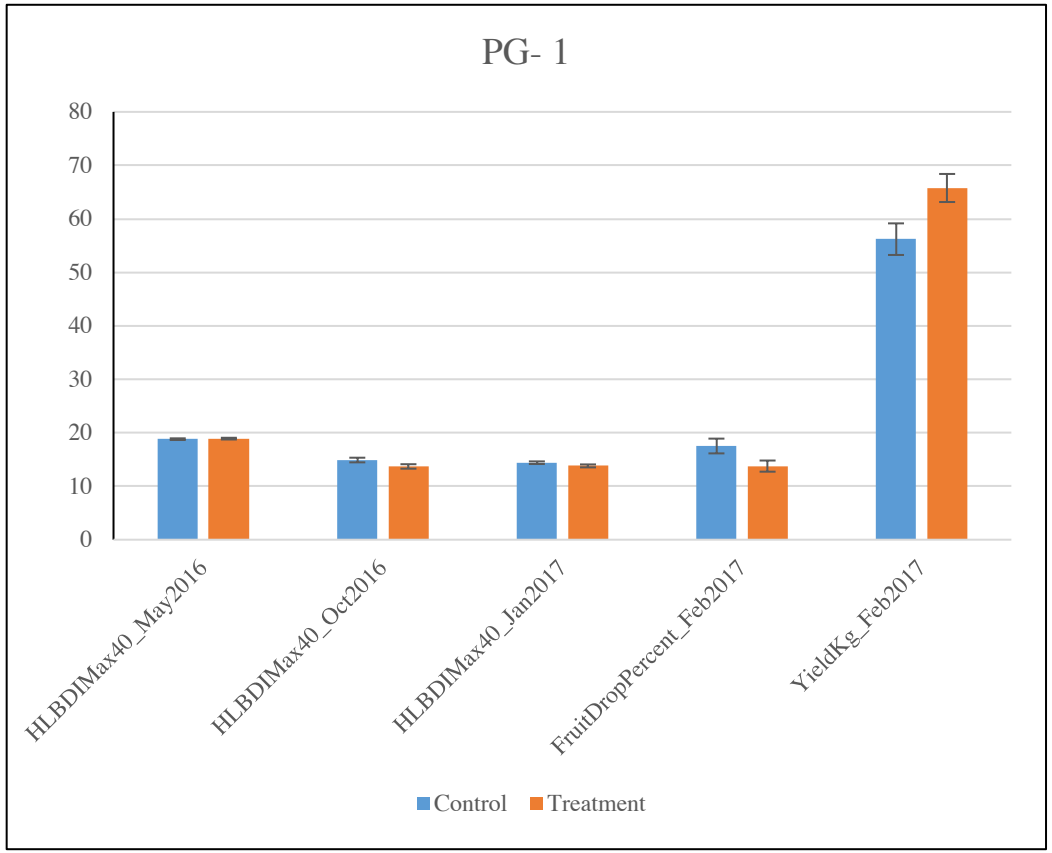
- Non-RCB
- Evaluating grower bactericide programs
  - Any adjuvant, tank mix, timing etc.
- Evaluation methods
  - 20 trees in four blocks in control and treatment row
    - Disease Severity (3x/year)
    - PCR (3x/year)
    - Yield
    - Fruit Drop

Variety	Number of Trials
Valencia	41
Hamlin	16
Grapefruit	11
Other	6

- 20 sites harvested

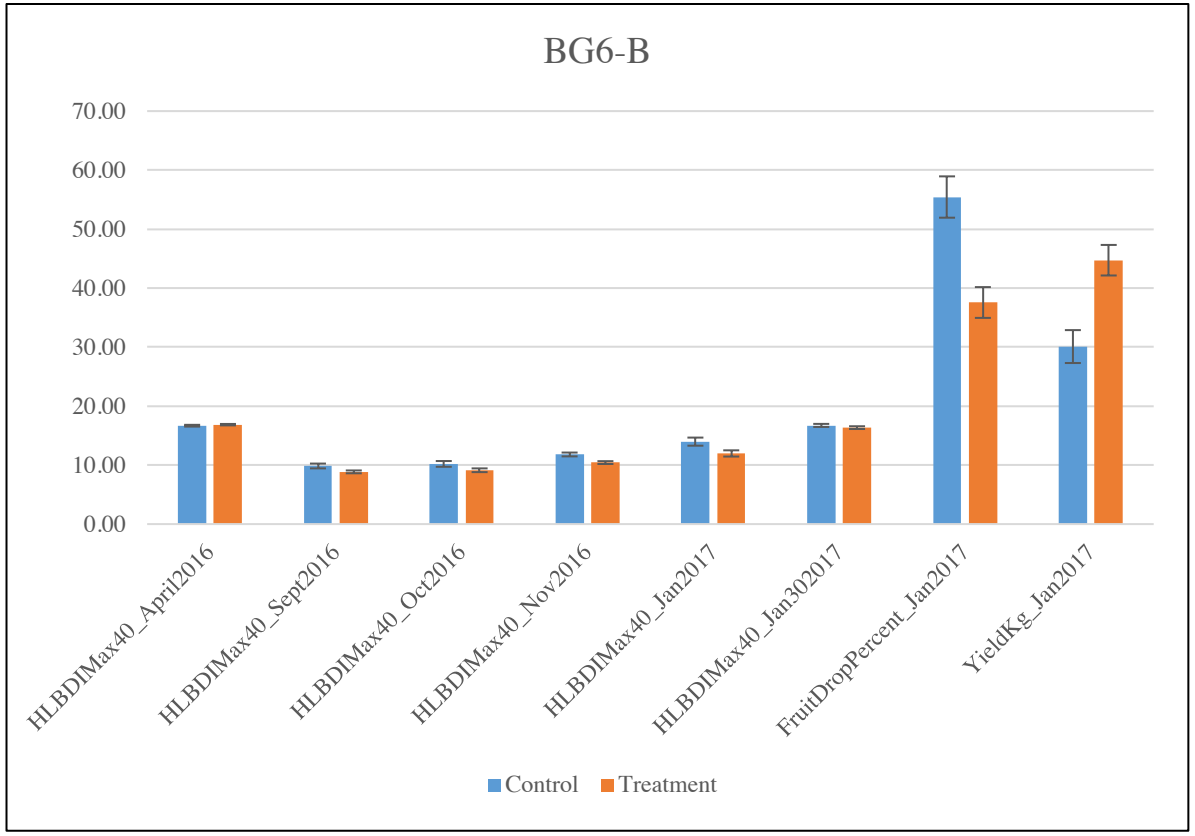
Grower Bactericide Trials

Valencia		Control		Treatment			
	N	Mean	Std Error	Mean	Std Error		
HLBDIMax40_May2016	20	18.80	0.16	18.90	0.16	p =	0.6727
HLBDIMax40_Oct2016	20	14.90	0.43	13.70	0.42	p =	0.0019
HLBDIMax40_Jan2017	20	14.40	0.24	13.80	0.28	p =	0.1059
CopyNumberPer100ngDNA_May2016	20	19571.02	4404.41	28182.07	4421.76	p =	0.1492
CopyNumberPer100ngDNA_Jan2017	20	2254.08	441.41	1214.87	203.99	p =	0.0488
FruitDropPercent_Feb2017	20	17.52	1.38	13.76	1.04	p =	0.0171
YieldKg_Feb2017	20	56.20	2.95	65.77	2.62	p =	0.0071



Grower Bactericide Trials

Grapefruit		Control		Treatment			
	N	Mean	Std Error	Mean	Std Error		
HLBDIMax40_April2016	40	16.68	0.15	16.85	0.12	p =	0.3867
HLBDIMax40_Sept2016	40	9.85	0.41	8.85	0.24	p =	0.0259
HLBDIMax40_Oct2016	40	10.20	0.49	9.13	0.32	p =	0.0573
HLBDIMax40_Nov2016	40	11.80	0.32	10.43	0.24	p =	0.0006
HLBDIMax40_Jan2017	40	13.98	0.69	11.98	0.53	p =	0.0145
HLBDIMax40_Jan302017	40	16.73	0.26	16.35	0.23	p =	0.2252
CopyNumberPer100ngDNA_April2016	40	195.04	157.75	973.99	825.81	p =	0.358
CopyNumberPer100ngDNA_Jan2017	40	113.10	40.27	174.99	72.51	p =	0.4591
FruitDropPercent_Jan2017	40	55.44	3.50	37.56	2.61	p =	<.0001
YieldKg_Jan2017	40	30.09	2.79	44.73	2.59	p =	0.0001



Bactericide Delivery

- Are the bactericides effective, but delivery not?
  - Improved delivery may improve efficacy
  - Trunk injection has been evaluated in the past
    - Are new formulations more effective?
    - Less phytotoxic?
  - Concerns
    - Multiple injections are not economical
    - Residues
      - Modification of the pesticide label requires new residue study

Bactericide Delivery

- CRDF Field Trial - Trunk injection versus foliar application
  - 2 Injection events versus three foliar applications
  - Results - No significant improvement in health
- What next?
  - Change concentration?
    - Residue problem?
  - Change Volume?
  - Change Injection Technology
    - Are there other application technologies that will improve uptake?
  - More work to be done

Conclusions

- What is the role of bactericides in HLB management?
  - Effect bactericides may support the industry in the short-term
- Why do we still have so few bactericides?
    - New effective materials have a long timeline
    - Need significant financial support
      - Citrus is a minor crop
  - Regulatory
    - Important cross-resistance concerns/human health
  - Delivery
    - How do we deliver bactericides to the phloem?

Thank you

CRDF is proud to provide support to the Florida citrus industry