AGROW AWARDS SHORTLISTED

geela
Governor's Environmental and Economic Leadership Award 2008

IC20
Investors' Circle Top 20

ASTIA
2008 Cleantech Innovator Award

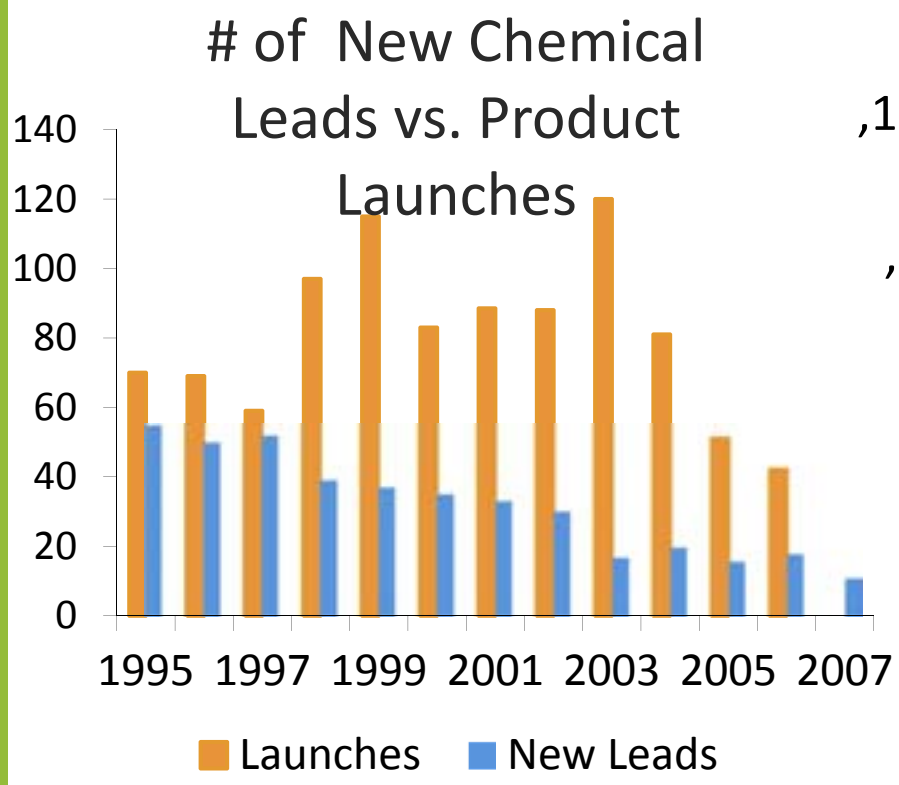
IPM INNOVATORS

Discovery & Development of Natural Products for Controlling Weeds

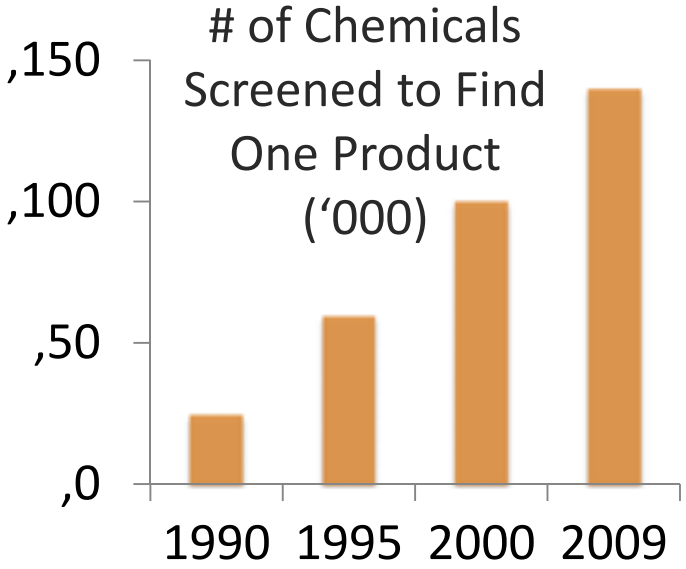
Pam Marrone, CEO & Founder

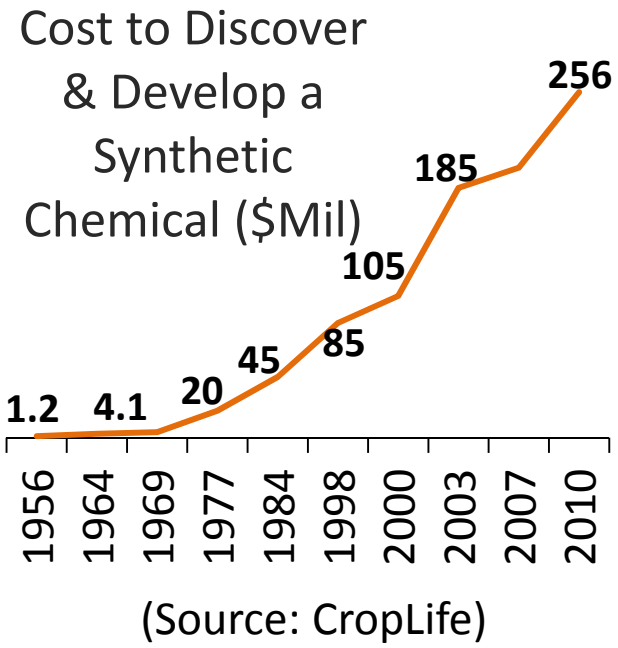
Marrone® Bio Innovations

Fewer New Chemicals – Higher Cost



Source: Ag Chem New Compound Review (Vol 25) 2007





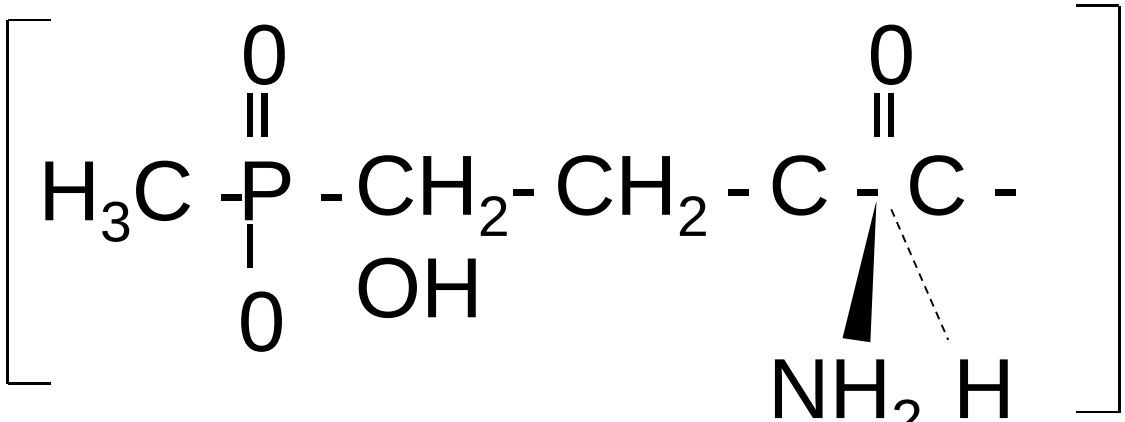
(Source: CropLife)

Increasing resistance to glyphosate; few new herbicidal modes of action since RR crops

Herbicides from Microorganisms

Basta - Glufosinate ammonium

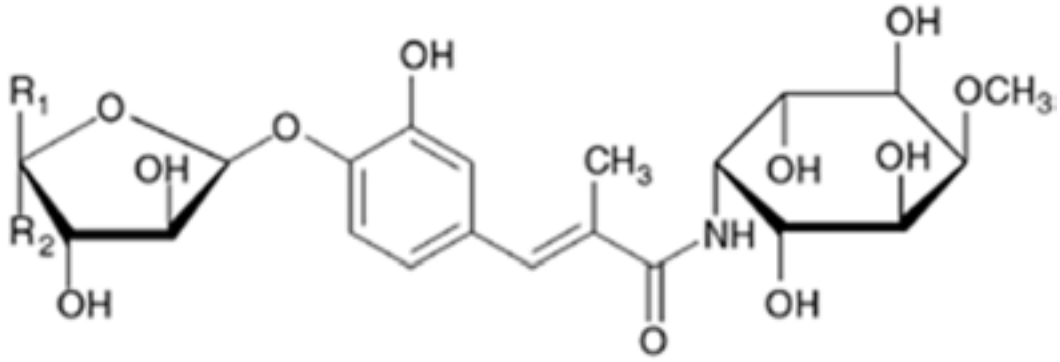
- Phosphinothricin (a breakdown product of bialaphos) discovered from *Streptomyces viridochromogenes* and *S. hygroscopicus*
- Inhibits the activity of the glutamine synthetase enzyme, which causes ammonia build-up in the cell.



Herbicides from Microorganisms

Methoxyhygromycin

- Produced by *Streptomyces* sp. 8E-12 (Korea)
- Bleaches and kills plants
- Has some selectivity to cucumber, rice, wheat and soybean



R_1: $COCH_3$ R_2: H Methoxyhygromycin

R_1: H R_2: $COCH_3$ Epi-methoxyhygromycin

Herbicides from Plants

Leptospermone

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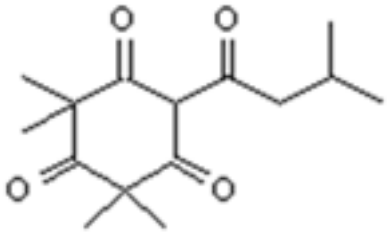
Callisto® HERBICIDE



- From the *bottlebrush tree* *Callistemon citrinus*
- Developed into Callisto® herbicide (mesotrione) by Syngenta
- Mesotrione inhibits an essential plant enzyme, HPPD (p-hydroxyphenyl pyruvate dioxygenase) that is found primarily in the cytoplasm of the chloroplasts

What We Do

*We discover, develop, and market **effective** and environmentally responsible natural products (biopesticides) that fill unmet needs for weed, pest & plant disease management.*

- **Products that improve yields and quality in conventional ag compared to chemical-only systems**
- **Products that lower the cost and increase yields in organic farming**
- **Products for water treatment and water bodies**

Company Overview

- Founded April 2006 by industry expert, serial entrepreneur Pam Marrone in Davis, California
- 54 employees; 12 PhD, 7 MS, 4 MBA, 30 BS, 1 AS
- Selling GreenMatch® Bioherbicide and Regalia® Biofungicide
- Products in advanced development:
  - Zequanox™ Invasive mussel product - launch early 2011
  - Two bioinsecticides and two bioherbicides waiting EPA approval – launch 2011/12
- 7 U.S., 10 international patents filed
- $23.5 million of invested equity capital

Microorganisms Isolated From Unique Habitats and Geographies

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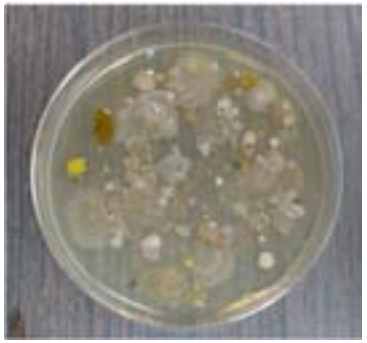
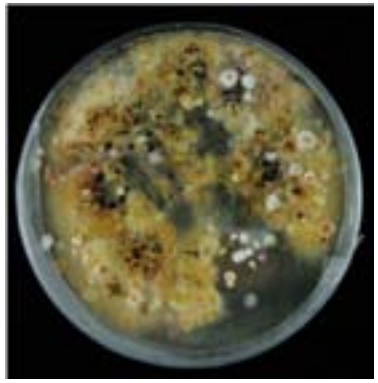
Samples from Areas of high biodiversity are cultured on specific media





Individual fungal, bacterial, and actinomycete colonies picked from primary plate

Purity is confirmed on separate plates

Fermentation broths are used for bioassays

Biological Efficacy Testing

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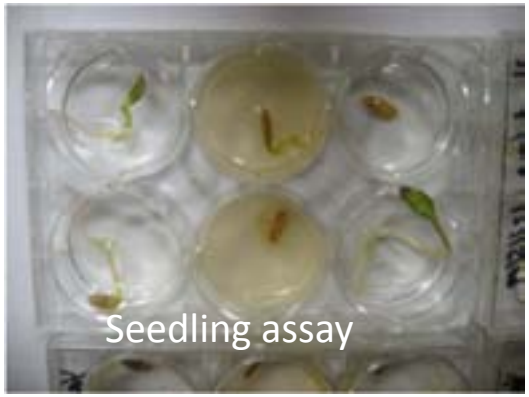
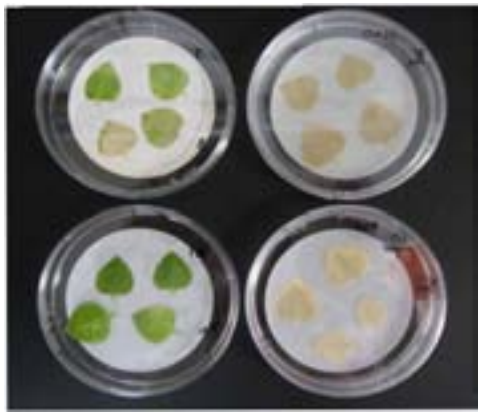
Nematode Screening



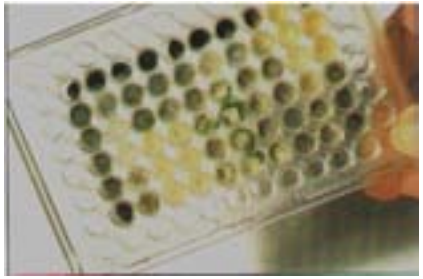
Herbicide Screening



In vivo screen

Weed screen includes high throughput enzyme assays for systemic mode of action

Plant Disease & **Insect testing** - miniaturized, automated assays vs. pest or plant pathogen



Seed Treatment & **Nutrient Efficiency** screens

Algaecide screening

Natural Product & Analytical Chemistry

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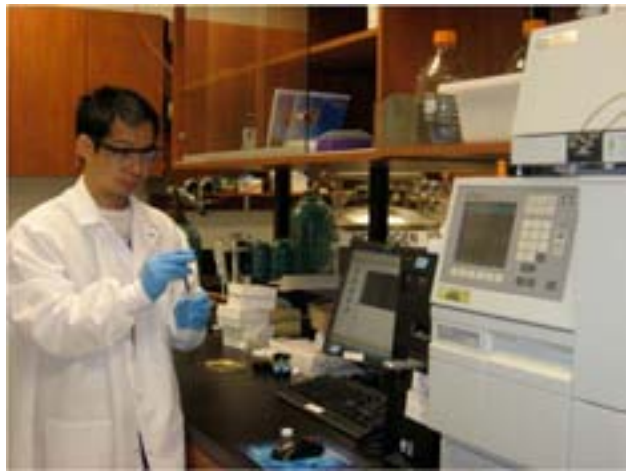
- Characterize/identify pesticidal compounds produced by the microbes or plants
- Eliminate strains with harmful compounds
- Develop analytical assays based on bioactive chemistry for QC



Fermentation and Formulation

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- Optimize processes
- Scale up - pilot & manufacturing
- Field trials
- Registration

Develop user-friendly formulations (wettable powder, WDG, liquid suspension, RTUs) & packaging

Product Pipeline

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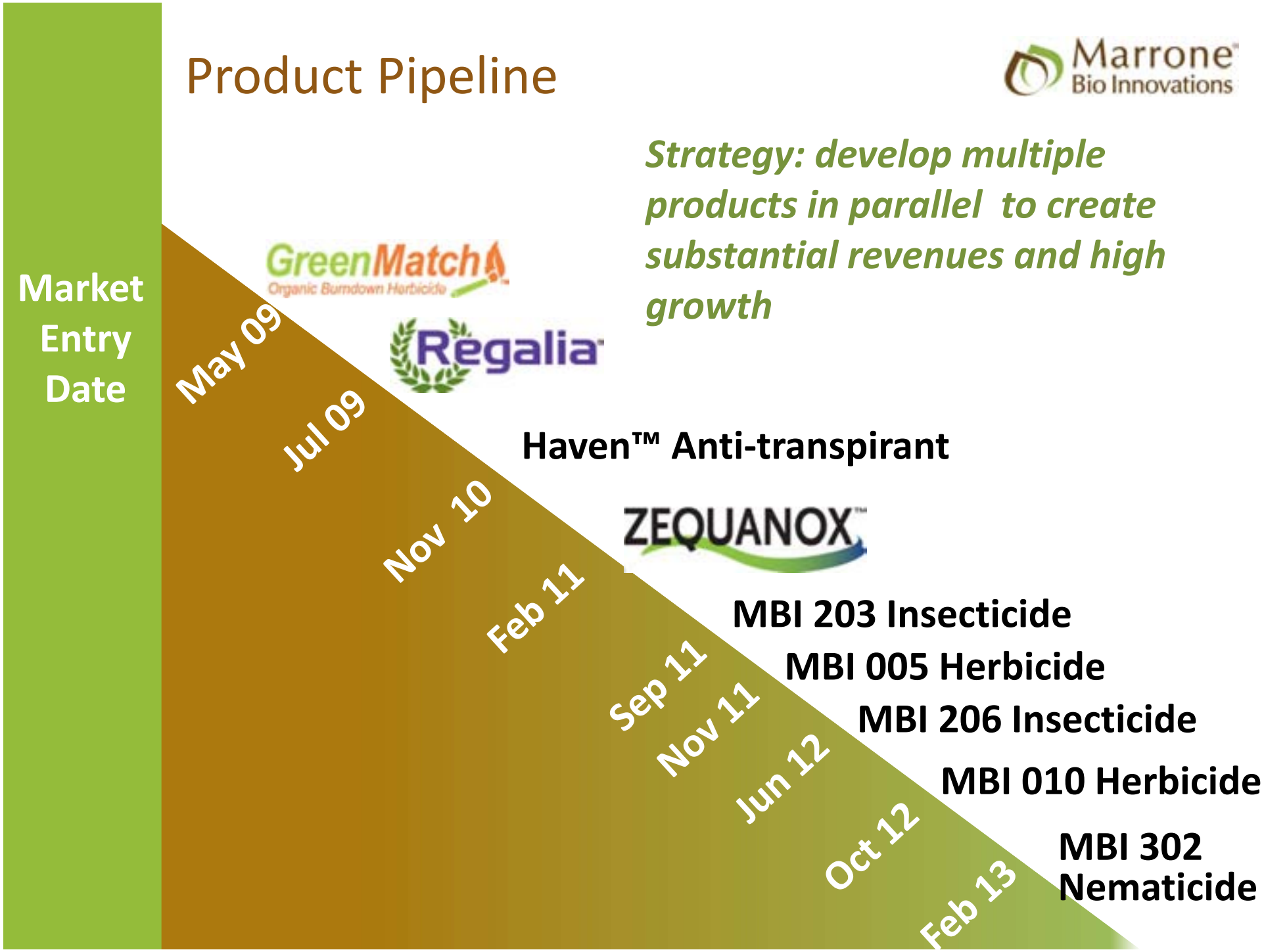
Strategy: develop multiple products in parallel to create substantial revenues and high growth



GreenMatch®

Burndown Herbicide

FOR ORGANIC PRODUCTION

Marrone Bio Innovations

OMRI Listed

Active Ingredient: d-limonene…….. 55%
Inert Ingredients:…..... 45%
Total: 100%

- An effective burndown for organic only – price of raw materials too high for conventional
- Good first entry into the market to understand what organic growers want for weed control compared to hand weeding, tractor cultivation, flaming and landscape fabric, etc.
- Will be replaced by other MBI products

Before and After - Examples

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Before Treated

After Treated with GreenMatch

Bindweed – Camarillo, CA
14 Days After Treated

Before Treated

After Treated with GreenMatch

14 DAT, 14% dil. 60 GPA

Bindweed – Yakima, WA
7 and 14 Days After Treated

After Treated with GreenMatch

7 DAT, 14% dil. 60 GPA

After Treated with GreenMatch

14 DAT, 14% dil. 60 GPA

Irrigation Channel – Gonzales, CA
14 Days After Treated

Before Treated

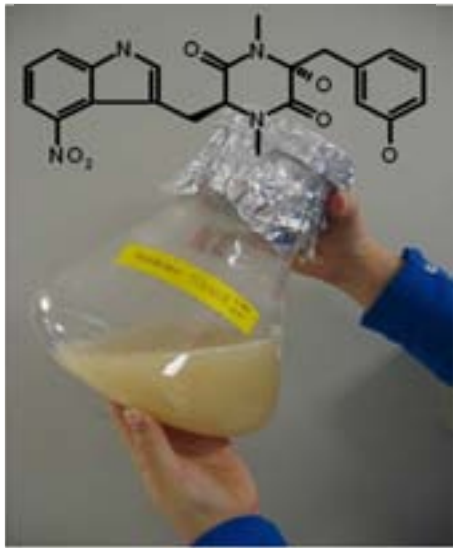
After Treated with GreenMatch

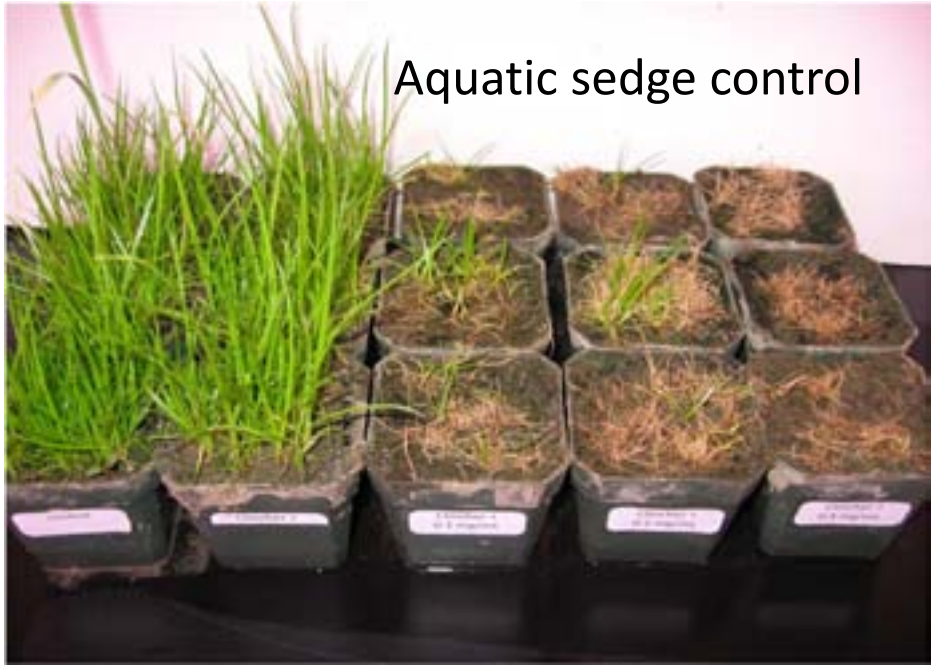
55F, 17% dil @ 65 GPA

MBI 005 – Selective Bioherbicide

Identified as active vs. sedges in rice by Dupont

- Broad spectrum control of broadleaf weeds and sedges
- **Uses:** Rice, corn, wheat, sugarcane, sorghum, turf
- **Active ingredient:** Thaxtomin **from** *Streptomyces spp.*
- **Regulatory status:** Pending at the EPA

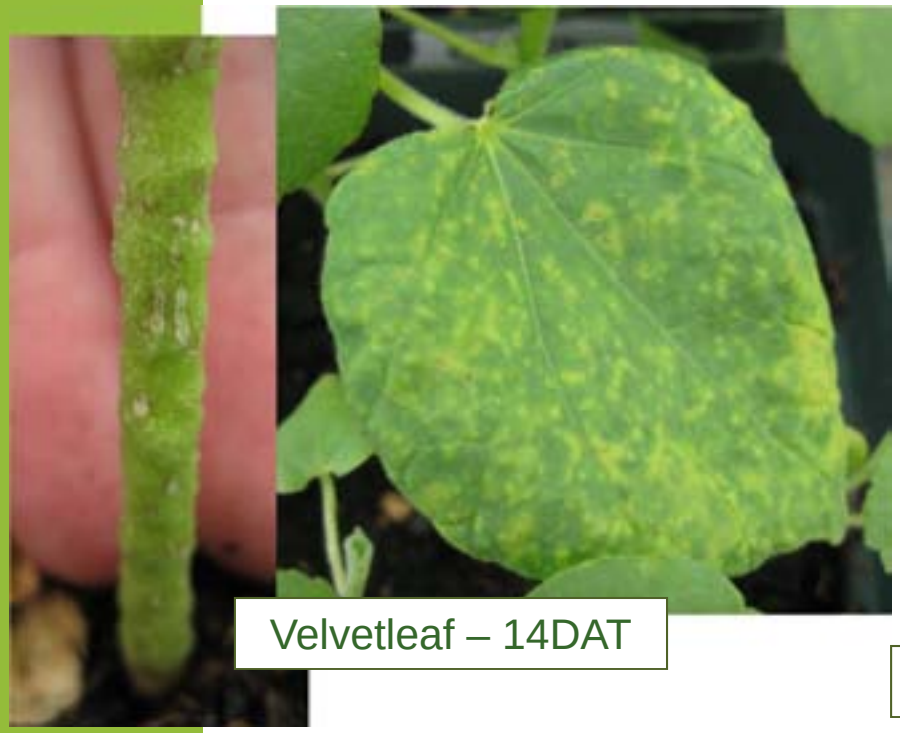




Aquatic sedge control

Lambsquarter – 7DAT

Dandelion – 7DAT



Velvetleaf – 14DAT

Sunflower – 7DAT

MBI 005 Efficacy on Rice Weeds - Sedge and Sprangletop (greenhouse)

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Rate of MBI-005 (arbitrary units)	*Cyperus difformis* (control %)			*Leptochloa sp* (% control)		
	5 days	12 days	21 days	5 days	12 days	21 days
0	0a	0a	0a	0	0a	0a
1	5a	15a	53b	0	0a	0a
2	12a	75b	90c	0	2a	3a
4	16a	77b	88c	0	10b	12a
8	25a	73b	83c	0	10b	17a

MBI 005 Tank Mix with Clincher® CA Greenhouse Test - Rice

Marrone Bio Innovations

Effect on the most common rice weeds in the Northern Central Valley in California was evaluated 8 days after treatment

MBI-005 @ increasing dose, with Clincher®)	Redstem % control	Waterplantain % control	Sedge % control	Sprangletop % control
UTC	0	0	0	0
0	75	8	0	90
2	100	85	87	100
4	97	87	88	100
8	100	85	100	100

Clincher® CA is a product of Dow AgroSciences

MBI 005 Good Dandelion Control

Marrone Bio Innovations

10DAT

Dandelion Test

Pre-treatment (17 days old)

UTC	MBI-005 1.0 mg/mL	MBI-005 0.5 mg/mL	Roundup 1 fl oz/gal

24DAT

Sarmentine as a Herbicide

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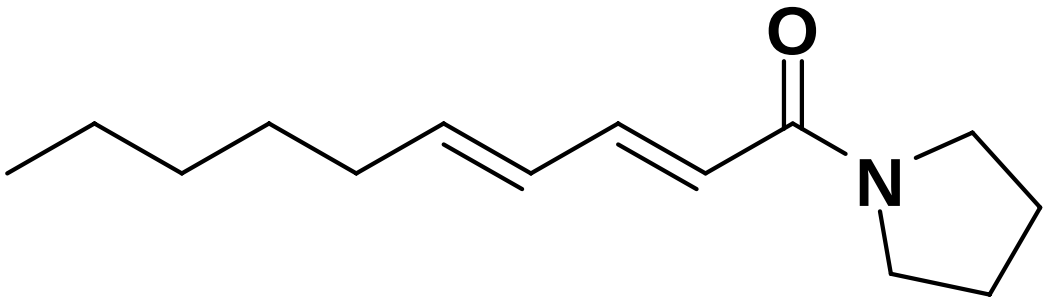
- Methanol extract of dry long pepper (*Piper longum* L.) fruits showed herbicidal activity in our screen
- Used in Chinese medicine and as an anti-oxidant and solubilizer of hydrophobic compounds in cosmetics
- At 5 mg/mL has good activity against most grass and broadleaf weeds
- Mode of action looks similar to pelargonic acid
- MBI filed a patent application for use of sarmentine to control plant pests



Control of different plant species when treated with 5.0 mg/mL Sarmentine

Plant name	Control	Plant name	Control
Pigweed (*Amaranthus retroflexus*, L.)	80-100%	Lambsquarters (*Chenopodium album* L.)	80-100%
Barnyard grass (*Echinochloa crus-galli* L.)	80-100%	Bluegrass (*Poa annua* L.)	80-100%
Bindweed (*Convolvulus arvensis*, L.)	80-100%	Wild mustard (*Brassica kaber* L.)	80-100%
Crabgrass (*Digitaria sanguinalis* L.)	80-100%	Black nightshade (*Solanum nigrum* L.)	80-100%
Horse weed (*Conyza Canadensis* L.)	< 20%	Curly dock (*Rumex crispus* L.)	80-100%
Sprangletop (*Leptochloa fascicularis* Lam.)	80-100%	Wheat (PR 1404) (*Triticum aestivum* L.)	80-100%
Dandelion (*Taraxacum officinale* F.)	80-100%	Rice (M 104) (*Oryza saliva* L)	0%

MBI 010 - Our "Organic Roundup®"

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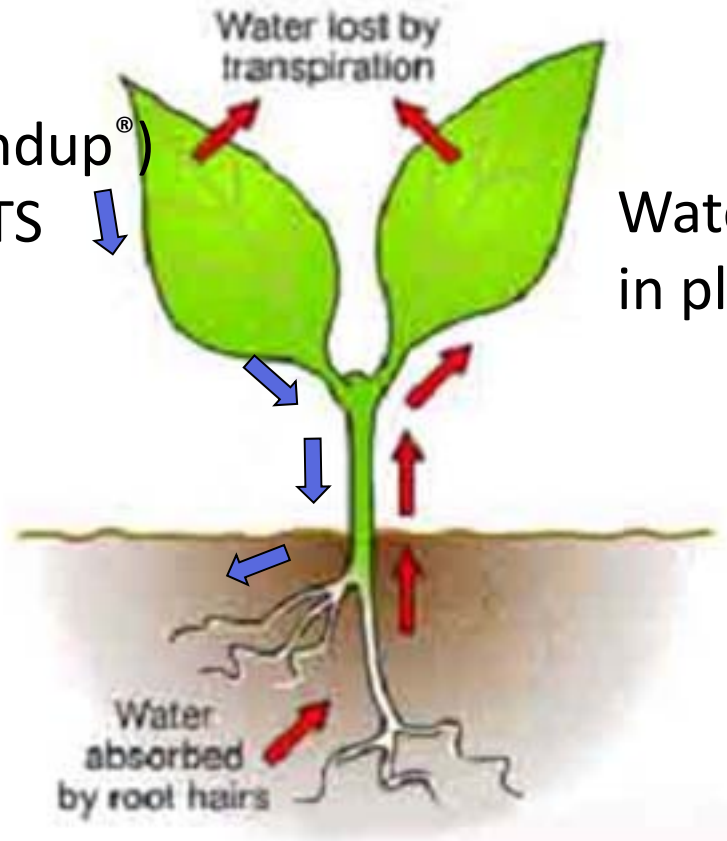
SYSTEMIC HERBICIDE

(e.g. glyphosate=Roundup®)

MOVEMENT IN PLANTS ↓

↓

Long term control of weeds – roots are killed after spraying the leaves



Water movement in plant ↑

- New species of bacteria discovered from our screen
- Two novel systemic compounds produced by the bacteria
- Broad spectrum weed control
- Not the same mode of action as glyphosate
- Fermentation and formulation are critical for activity

Phoma macrostoma
Bioherbicide

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

- Karen L. Bailey, Agriculture and Agri-Food Canada (AAFC)
- Discovered from diseased sow thistle
- Licensed to Scott's for turf
- Control of: dandelion (68%), field bindweed (60%), annual sow thistle (97%), and wild mustard (82%).
- Some reduction in perennial sow thistle, smart weed, Canada thistle, false cleavers, hemp nettle, and Brassica (25-50%).
- No effect on stinkweed, lambs quarters, and wild oat.
- Best on emerging seedlings; less effective on well established weeds using a single application

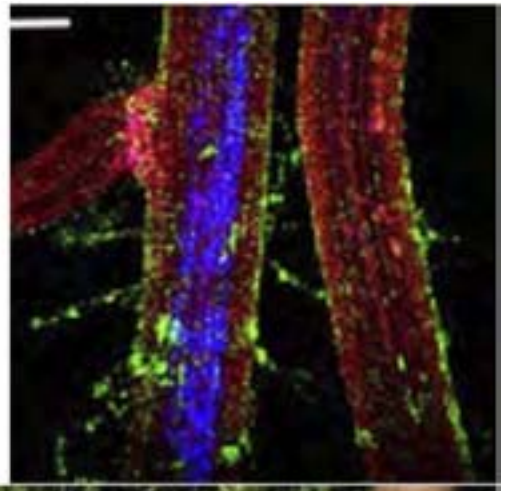
Pseudomonas fluorescens Strain BRG 100

"Pesto" formulation

Sue Boyetchko & Russell Hynes, AAFC

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Pseudomonas fluorescens
Strain BRG 100



Pre-emergence annual grass control in wheat

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Bioherbicides – an Emerging New Category for Biopesticides

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- There is a need for new modes of action for weed control
- Efficacy can equal chemicals
- Can be combined with chemical pesticides for better weed control
- In some cases, costs can compete with chemical products
- Microbial strain selection, characterization of associated herbicidal compounds, and formulation are keys to efficacy

pmarrone@marronebio.com

1-530-750-2800 (office)

www.marronebioinnovations.com

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