The General Need for Effective and Economical Bioherbicides

Stephen O. Duke

Stephen.Duke@ARS.USDA.GOV
Köhler & Triebskorn – 2013 – Science 341: 759

The diagram illustrates the annual amount of pesticide active ingredient used from 1988 to 2010 in the U.S., Japan, and EU countries. The graph shows the proportion of herbicides, fungicides, and insecticides used over the years.
Data from: Timmons, 1970; Appleby, 2005, and HRAC

United States Department of Agriculture – Agricultural Research Service

IR-4 biopesticide workshop – Sept. 10, 2014
another fine mess you've gotten us into
Solutions:

New herbicides with old MOAs?

Old herbicides/new resistant crops?

Bioherbicides?

New herbicides with new MOAs?
Biopesticides according to EPA

- Microbial pesticides (biocontrol organisms, such as mycoherbicides)
- Biochemical pesticides
- Plant-incorporated protectants (e.g., $Bt$ toxin produced by a transgene)
Biochemical pesticide

- Naturally occurring substance that controls pests by non-toxic mechanisms

- Biochemical pesticides include substances, such as insect sex pheromones, that interfere with mating, as well as various scented plant extracts that attract insect pests to traps.

- Because it is sometimes difficult to determine whether a substance meets the criteria for classification as a biochemical pesticide, EPA has established a special committee to make such decisions.
Biochemical Biopesticides Approved by EPA (1997-2010)

- Insecticide: 66%
- Fungicide: 27%
- Herbicide: 7%
Biological control organisms by pesticide target approved by EPA (1996-2010)
**Biopesticide Candidates: 01/12 - 03/13**

- **US Patents Granted**
- **US, EP and WTO patent Applications**

**Insecticides**
- US Patents: 6
- Applications: 10

**Fungicides**
- US Patents: 9
- Applications: 18

**Herbicides**
- US Patents: 1
- Applications: 1

*1 has both insecticidal & fungicidal activity*

Biochemical bioherbicide options for green and organic production

Bioherbicides
Approved bioherbicidal products for organic weed management

- Essential oils
- Crude botanical preparations
- Vinegar
- Natural lipids and soaps
Example of essential oil

- 50% lemon grass oil (rich in d-limonene)
- Non-selective

**GreenMatch® EX**

- For Control of Grasses and Broadleaf Weeds in Crop and Non-Crop Areas
- CONCENTRATED EMULSION
- NO REENTRY INTERVAL
- Ingredients in this product meet the requirements of the USDA National Organic Program

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Percentage</th>
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<tr>
<td>Lemon grass oil</td>
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</table>

Other Ingredients:
- Total: 100%

* Water, Corn Oil, Glycerol Esters, Potassium Oleate and Lecithin

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Organic acids

- 20% citric acid
Horticultural vinegar

- 20% acetic acid from a natural source with yucca extract as a sticker
Mixtures

- 12% clove oil, 8% sodium laural sulfate and also vinegar and citric acid
Chelated iron products (FeHEDTA) – hazardous ingredients - NaNO$_3$ and nitrilotriacetate
Crude botanical preparation

- Crab grass killer – 0.95% cinnamon bark
- Somewhat selective
- Effective at > 500 kg/ha formulated product
Downside to these products

- Poor efficacy
- Very high use rates
- High cost
- Mostly non-selective
## Comparative Costs of organic weed management

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Cost</th>
<th>1(^d)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Application cost</th>
<th>Total cost</th>
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<td>6,300</td>
<td>700</td>
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<td>—</td>
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<tr>
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<td>50/kg ae</td>
<td>40</td>
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<td>—</td>
<td>—</td>
<td>—</td>
<td>70</td>
<td>110</td>
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<tr>
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<td>22/kg ai</td>
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<td>1,580</td>
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<td>—</td>
<td>—</td>
<td>150</td>
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<tr>
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<td>1,220</td>
<td>1,820</td>
<td>3,650</td>
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<td>300</td>
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<tr>
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<td>30</td>
<td>30</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>150</td>
<td>210</td>
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<tr>
<td>Pine oil</td>
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<td>1,390</td>
<td>2,070</td>
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<td>—</td>
<td>150</td>
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<tr>
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<td>1,820</td>
<td>2,430</td>
<td>3,650</td>
<td>370</td>
<td>11,910</td>
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*United States Department of Agriculture – Agricultural Research Service*
Typical example of pest management costs in organic agriculture

Organic strawberries in California

Weed management - $2085/A
Other pest management - $696/A

Bialaphos – Only herbicide currently sold that is produced by fermentation

Tripeptide proherbicide converted to L-phosphinothricin in target plant
Better bioherbicides are badly needed to solve problems of both greener conventional and organic weed management

Economical and effective bioherbicides =

The holy grail of biopesticides
THANK YOU FOR LISTENING