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Microbial-based biological control of invasive weeds: learning from the past and looking to the future

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History

- 1942 – The U.S. begins an offensive biological weapons program at Camp Detrick, MD.
- 1954-1971 - US Army Plant Sciences Directorate Research Laboratory
- 1971 - USDA Plant Disease Research Laboratory (PDRL)
- 1979 - USDA ARS Foreign Disease Weed-Science Research Unit



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Foreign Disease-Weed Science Research Unit Personnel

- 12 Principal Investigators (Ph.D.) – 4 “units”
- 9 Support Scientists (M.S. level)
- 8 Biological Sciences Technicians
- 6 Administrative Staff
- **3 Postdoctoral Fellows**
- **Students (Undergraduate and High School)**



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Research Programs

- Threatening and Emerging Foreign Plant Diseases
- Biological Control of Invasive Weeds with Plant Pathogens



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Weed Biological Control Research Mission and Approach

- Explore for pathogens on weed hosts
- Evaluate efficacy, host range (specificity)
- Determine risk of release in containment
- Obtain permits for release in U.S.
- Monitor and evaluate weed control



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Past Releases

- Musk Thistle Rust (Turkey) = *Puccinia carduorum* (1987)
- Yellow Starthistle Rust (Turkey) = *Puccinia jaceae* (2008)
- Canada Thistle Rust = *Puccinia punctiformis*



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Ramularia crupinae for biological control of Common Crupina

- *Crupina vulgaris*
- Asteraceae
- Winter Annual
- Native to the Eastern Mediterranean and the Middle East



http://www.wa.gov/agr/weedboard/weed_info/gallery/crupina.html



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Importance

- Introduced to the US
- Listed, “Federal noxious weed”, 1968
- Idaho, California, Washington, and Oregon
- Pest of: Grasslands, Shrub steppe, woodlands



http://www.wa.gov/agr/weedboard/weed_info/gallery/crupina.html

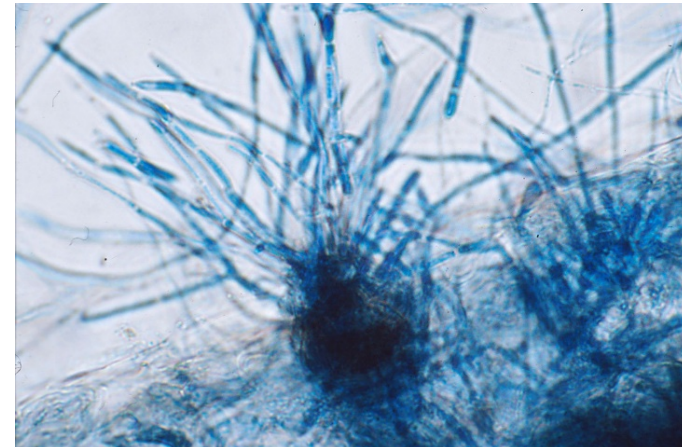


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Ramularia crupinae

- Facultative necrotroph
- Causes leaf and stem infections
- Field damage to naturally-infected plants
- Host specific in greenhouse studies





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Damage to Inoculated Plants





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Biomass

Average Dry Weights (g) per plant

<u>Treatment</u>	<u>Tops</u>	<u>Roots</u>
Control	4.55a	4.29a
Inoculated	3.22b	1.47b



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Seeds

Average Seed Counts and Seed Weights (g) per plant

<u>Treatment</u>	<u>Seeds</u>	<u>Seed Wt.</u>
Control	66.8a	1.99a
Inoculated	54.2b	1.61b



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Plant Damage

Roots (dried)



35%

100%

One Inoculation

Control



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Swallow-wort, Pale & Black ***(Vincetoxicum spp.)***

- Invasive perennial (Mediterranean/Eastern Europe)
- “Dog-strangling vine”
- Prolific seed producer and adaptable to a variety of environments
- Dominates woodlands and agricultural/natural fields





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Emerging pathogens?





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Current evaluations

- *Swallow-wort, Japanese Hop, Mile-a-minute, Japanese honeysuckle, Garlic mustard*



Stakeholder Supported Target List- Worst of the worst

<u>U.S. Status</u>	<u>Common Name</u>	<u>Scientific Name</u>
Invasive	Common reed	<i>Phragmites australis</i>
Invasive	Giant reed	<i>Arundo donax</i>
Invasive	Flowering Rush	<i>Butomus umbellatus</i>
Invasive	Lesser celandine/Fig buttercup	<i>Ranunculus ficaria</i>
Invasive	Purple loosestrife	<i>Lythrum salicaria</i>
Invasive	Yellow Flag Iris	<i>Iris pseudacorus</i>
Invasive	Japanese hop	<i>Humulus japonicas</i>
Invasive	Black and Pale Swallow-wort	<i>Vincetoxicum spp.</i>
Invasive	Garlic mustard	<i>Alliaria petiolata</i>
Invasive	Goatsrue	<i>Galega officinalis</i>
Invasive	Mile-a-minute	<i>Persicaria perfoliata</i>
Invasive	Oriental bittersweet	<i>Celastrus orbiculatus</i>
Invasive	Japanese honeysuckle	<i>Lonicera japonica</i>
Invasive	Wavyleaf basketgrass	<i>Oplismenus undulatifolius</i>
Endemic	Palmer amaranth	<i>Amaranthus palmeri</i>
Invasive	Glossy buckthorn	<i>Frangula alnus</i>
Invasive	Japanese stiltgrass	<i>Microstegium vimineum</i>
Invasive	Hydrilla	<i>Hydrilla verticillata</i>
Invasive	Japanese angelica tree	<i>Aralia elata</i>
Invasive	Japanese barberry	<i>Berberis thunbergii</i>
Invasive	Japanese knotweed	<i>Fallopia japonica</i>
Invasive	Multiflora rose	<i>Rosa multiflora</i>
Invasive	Poison hemlock	<i>Conium maculatum</i>
Endemic	Tall waterhemp	<i>Amaranthus tuberculatus</i>



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[https://www.ars.usda.gov/northeast-
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