KNOTWEED RESEARCH UPDATE

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Photo by Todd Larsen

KNOTWEEDS (*Fallopia* spp.)

Some key issues:

1) Taxonomic issues
2) Genetic characterization
3) Managing vegetative growth
4) Managing seed production
5) Herbicidal control challenges
6) Manual control challenges
7) Biological control prospects

COLLABORATOR ACKNOWLEDGEMENTS…

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CLEMENTS ET AL. 2016

Invasive Plant Science and Management 2016 9:60–70

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WEED SCIENCE SOCIETY OF AMERICA

Knotweed Management Strategies in North America with the Advent of Widespread Hybrid Bohemian Knotweed, Regional Differences, and the Potential for Biocontrol Via the Psyllid *Aphalara itadori* Shinji

David R. Clements, Todd Larsen, and Jennifer Grenz*

GILLIES ET AL. 2016

Invasive Plant Science and Management 2016 9:71–80

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Knotweed (*Fallopia* spp.) Invasion of North America Utilizes Hybridization, Epigenetics, Seed Dispersal (Unexpectedly), and an Arsenal of Physiological Tactics

Sharon Gillies, David R. Clements, and Jennifer Grenz*

COLLABORATOR ACKNOWLEDGEMENTS…

Christine Gile

Sterling Balzer

Matthew Strelau

Michael Bogress

Invasive plants

Student joins fight against knotweed

Research looks at pesky plant's ability to build up resistance to herbicide

Amy Reid
Now staff
Twitter @amyreid87

Matthew Strelau is studying whether knotweed will build up a resistance to the herbicide used to treat it. (Photo: AMY REID)

Knotweed will not take over British Columbia if Matthew Strelau has anything to say about it.

The Surrey resident is studying whether the invasive bohemian knotweed plant will

programs manager, said Surrey has a few hundred known invasive plant sites, and that list continues to grow.

The city also works to educate the community, seeing as residents are often the ones depositing invasive species in the first place, he explained.

"One of the ways invasive plants get into our forests are from dumping. People dumping yard waste.... They chuck it over the fence into the forest," Aven noted.

Last week, the *Now* reported that some locals were shocked to learn the city was

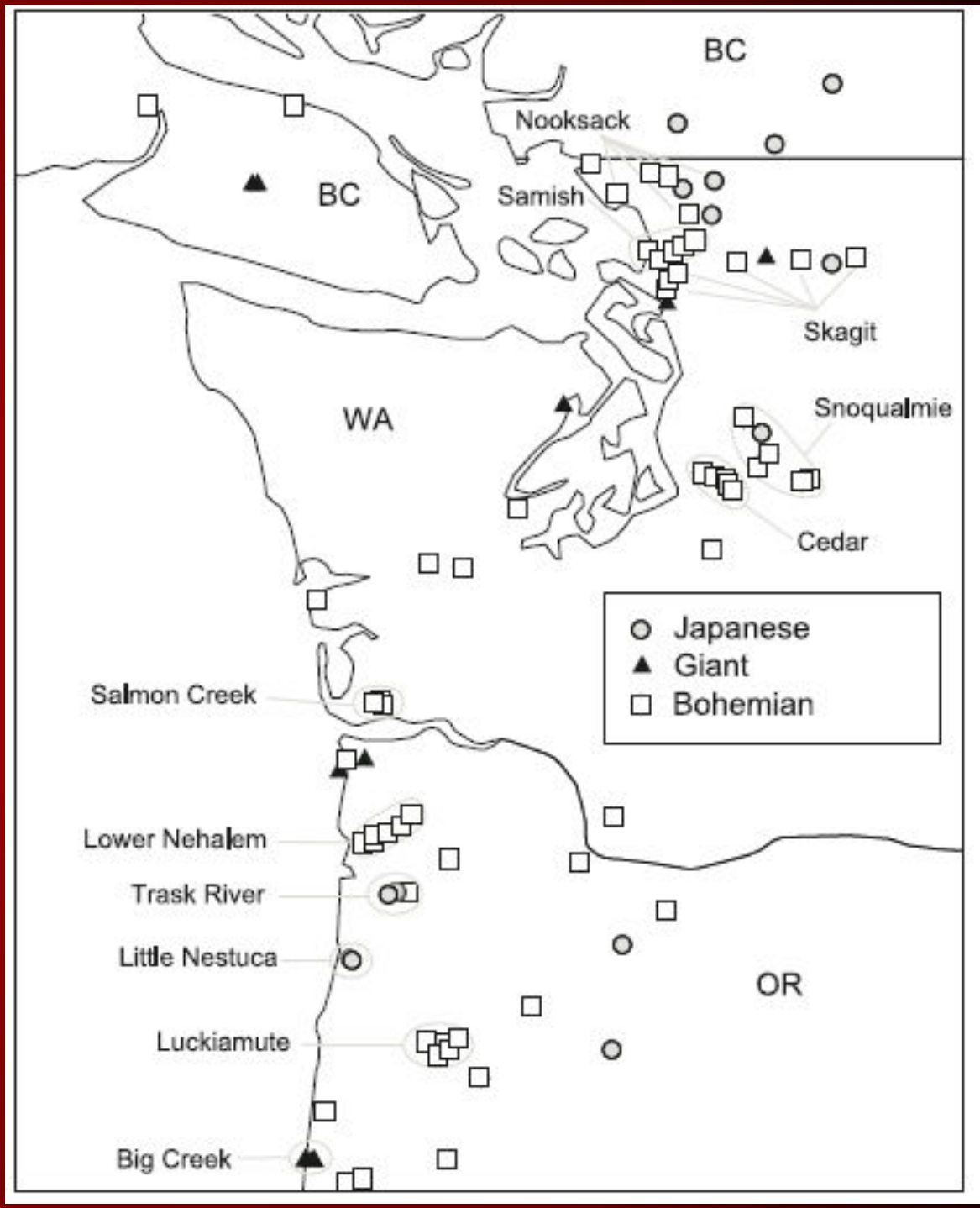
#1. TAXONOMIC ISSUES

- Until recently, *Fallopia japonica* was thought to be the dominant knotweed species in North America
- Because the clone is male sterile it is unable to produce viable seeds
- However, recent research has shown that the hybrid *Fallopia* × *bohemica*, a cross between *F. japonica* and *F. sachalinensis* produces viable seeds

#2 GENETIC CHARACTERIZATION

- Gaskin et al. (2014)* sampled leaf material from 131 knotweed populations from the Pacific Northwest
- Used amplified fragment length polymorphisms to identify genotypes
- Japanese knotweed genotype (n = 130 plants) was genetically identical to UK Japanese knotweed UK
- Bohemian knotweed was the most common taxon (71 % of all plants)

*Biol Invasions 16:2127–2136



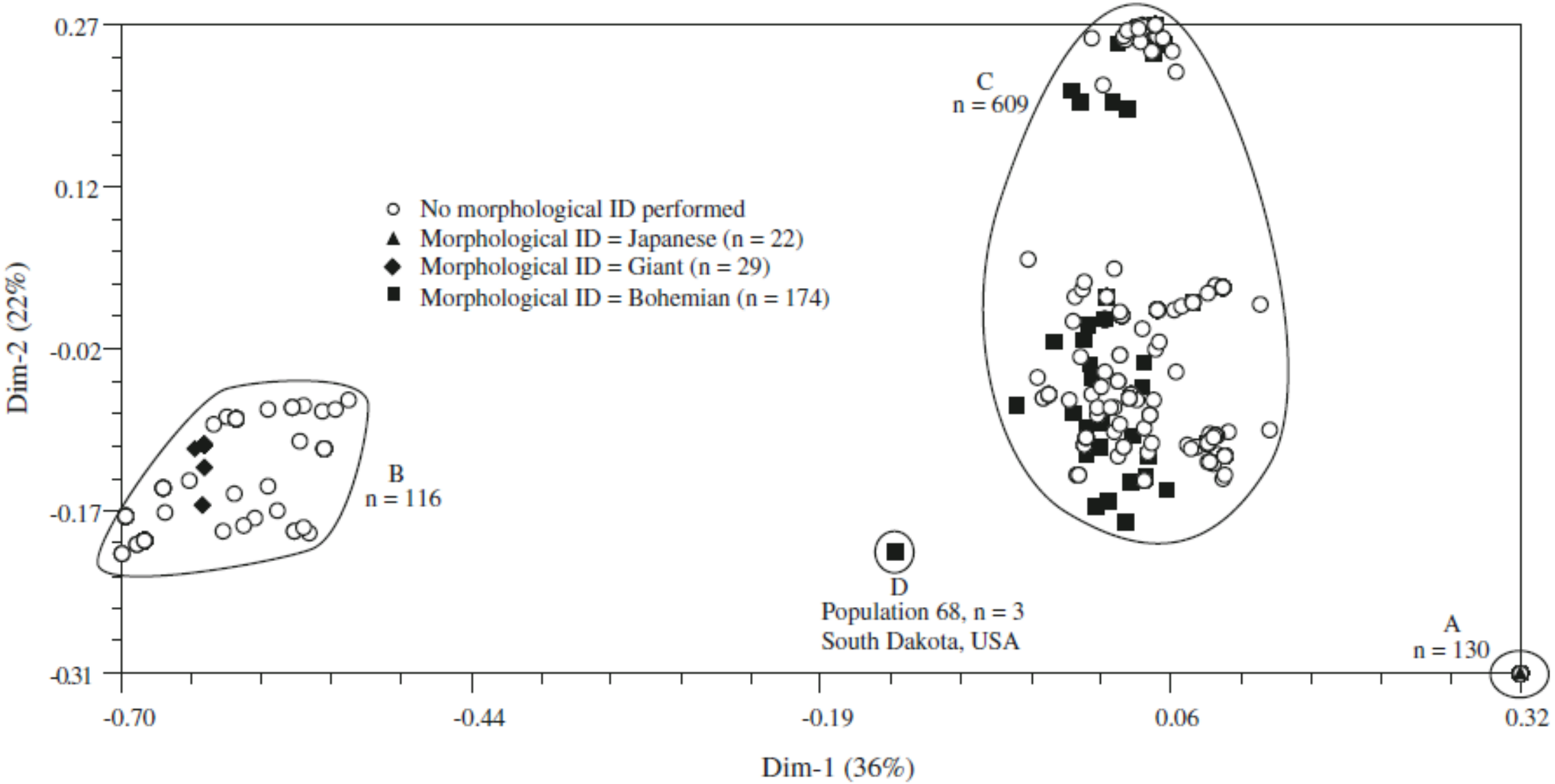


Fig. 2 Principal coordinates analysis of knotweed plants from western North America (n = 858). *Squares* plants morphologically identified as Bohemian knotweed, *diamonds* morphologically identified as giant knotweed, *triangles* morphologically identified as Japanese knotweed, *circles* plants that were not morphologically identified. Four genetic clusters each with 100 % bootstrap support in a UPGMA analysis are identified by closed curves marked as *A*, *B*, *C* and *D*

#3 MANAGING VEGETATIVE GROWTH

- Knotweeds produce an extensive rhizome network extending 15–20 m in length and penetrating 2–3 m deep in soil, making up 2/3 of total plant biomass
- Vegetative growth generally thought to be the major method of spread for knotweeds in Europe and North America
- Yet in its native Japan, seedling recruitment is more important
- Manual control of knotweed (mowing, digging etc.) often makes vegetative spread worse because plants can regenerate from buds on small rhizome fragments as small as 0.6 g (e.g., hand-pulling in Wales for 10 years* did not exhaust the rhizome bank!!!)

*Baker 1988 Asp. Appl. Biol. **16**: 189–192.

#4 MANAGING SEED PRODUCTION

- A single Japanese knotweed stem can produce as many as 191,892 seeds - so if just 10% germinated = 19,000 per stem
- Grenz has observed seedling emergence in knotweed patches in BC
- Likewise, in the summer of 2015, Sterling Balzer observed emergence from some patches and found preliminary evidence for glyphosate tolerance / resistance in lab tests

#5 HERBICIDAL CONTROL CHALLENGES

Control options recommended in British Columbia

Small patches:

i. Cutting
ii. Digging
iii. Smothering
iv. Injecting

Large patches:

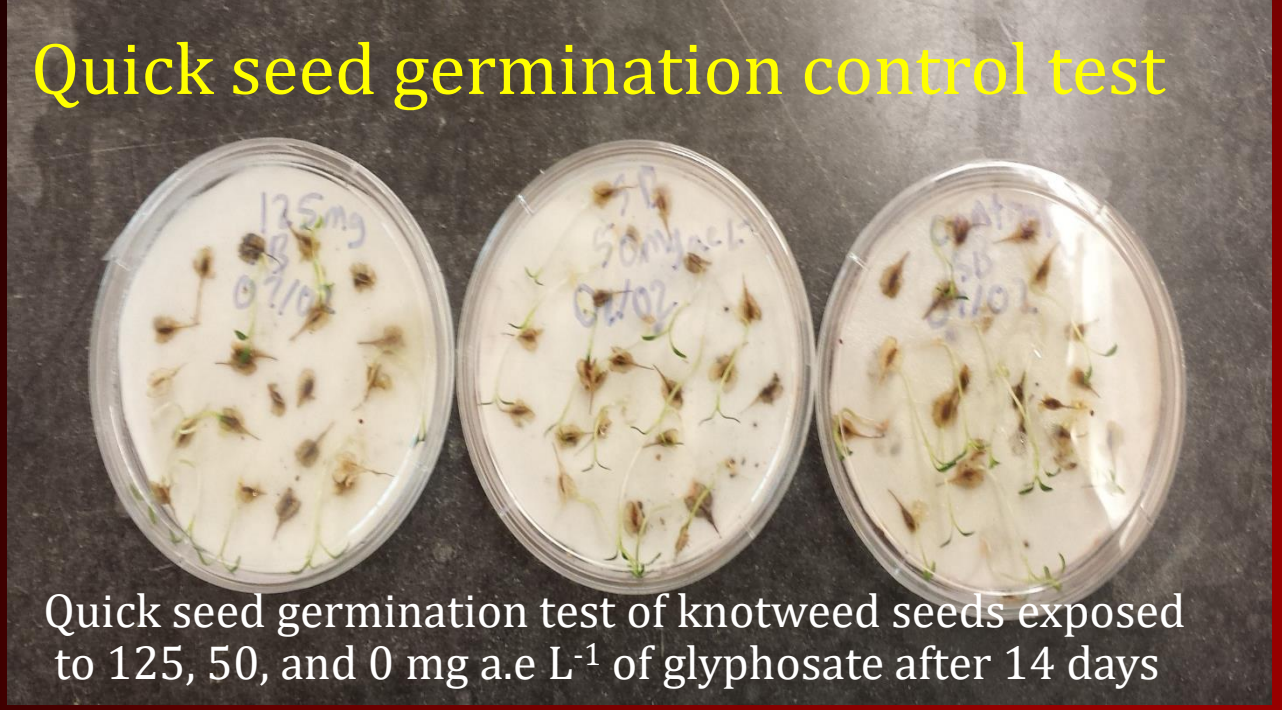
i. Excavator/foliar spray
ii. Machete/foliar spray
iii. “Cut and fill”/foliar spray

Do these treatments kill the roots?

- glyphosate injections do not fully eradicate the knotweed; rhizomes may go dormant
- frequently repeated treatments required

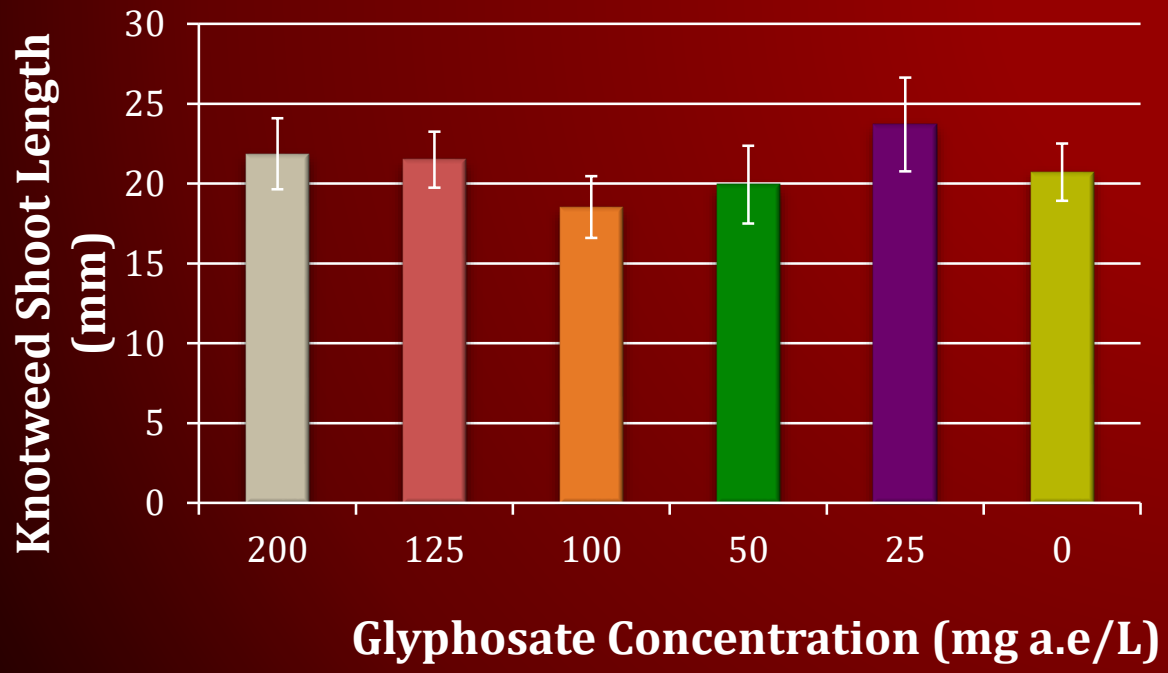
Stem injection of glyphosate (Jennifer Grenz)

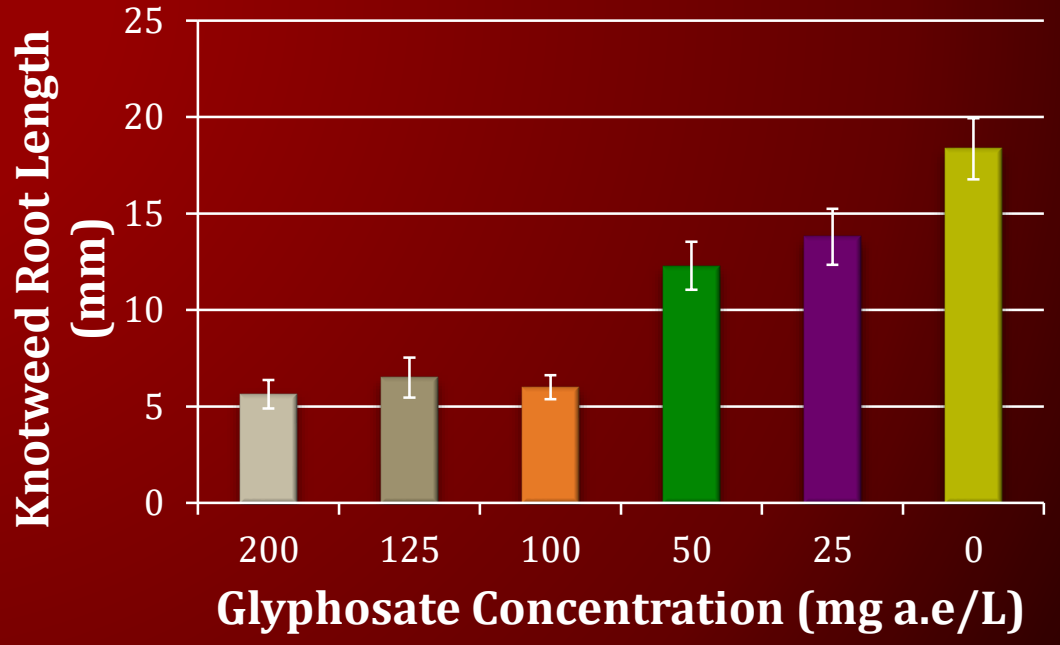
Quick seed germination control test



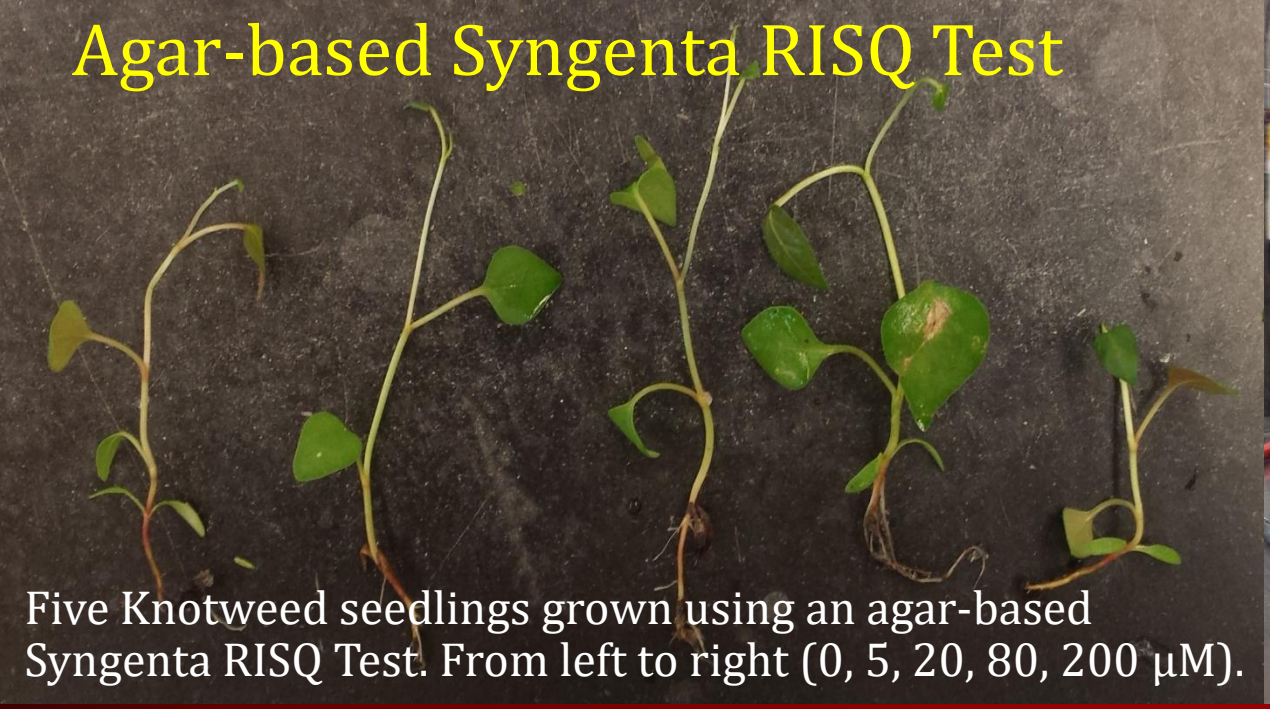
Quick seed germination test of knotweed seeds exposed to 125, 50, and 0 mg a.e L^{-1} of glyphosate after 14 days

Day 1 of knotweed quick seed germination control test





Agar-based Syngenta RISQ Test

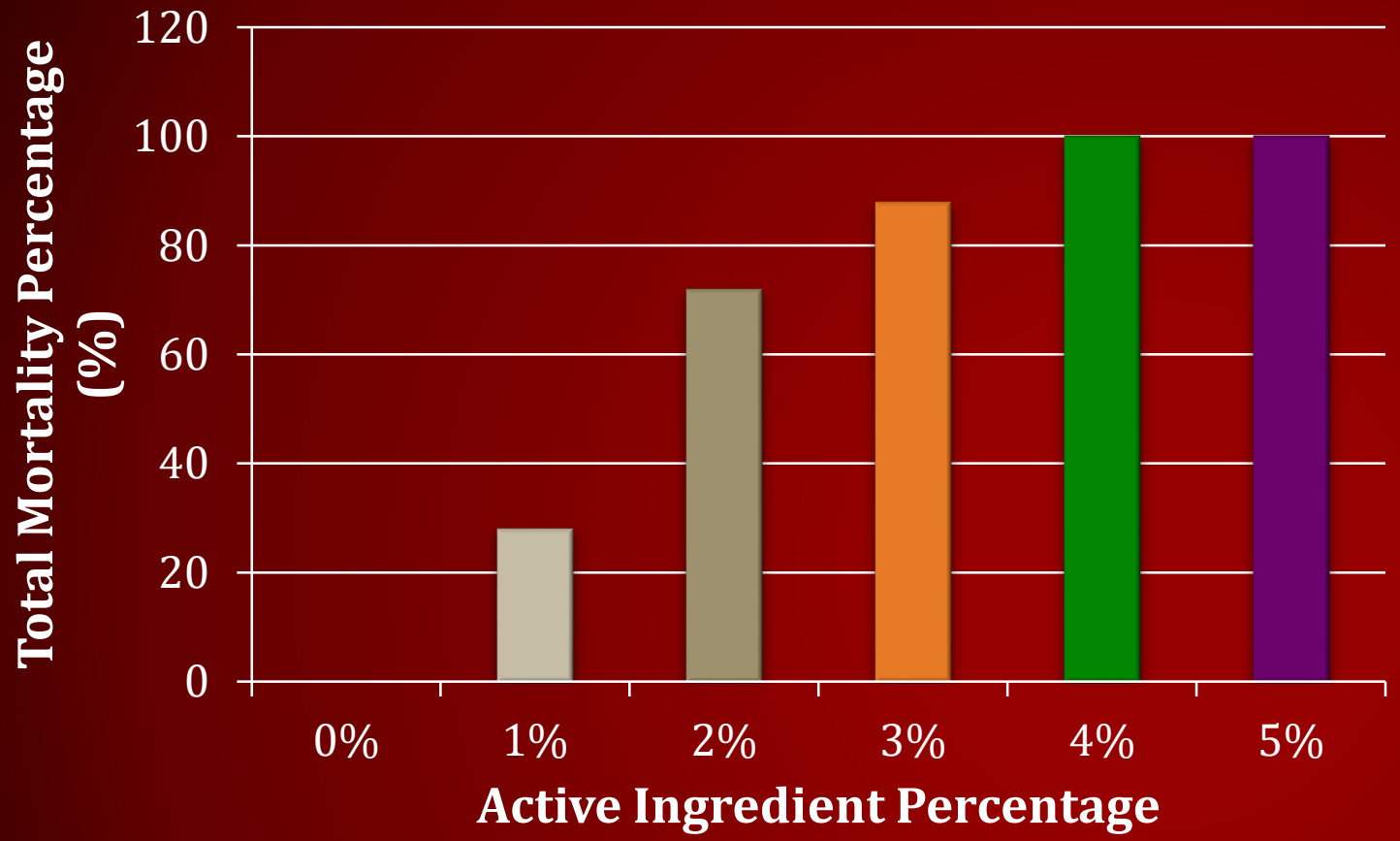


Five Knotweed seedlings grown using an agar-based Syngenta RISQ Test. From left to right (0, 5, 20, 80, 200 µM).

Knotweed seedlings in growth jars containing glyphosate concentrations (0, 5, 20, 80, 200 µM)

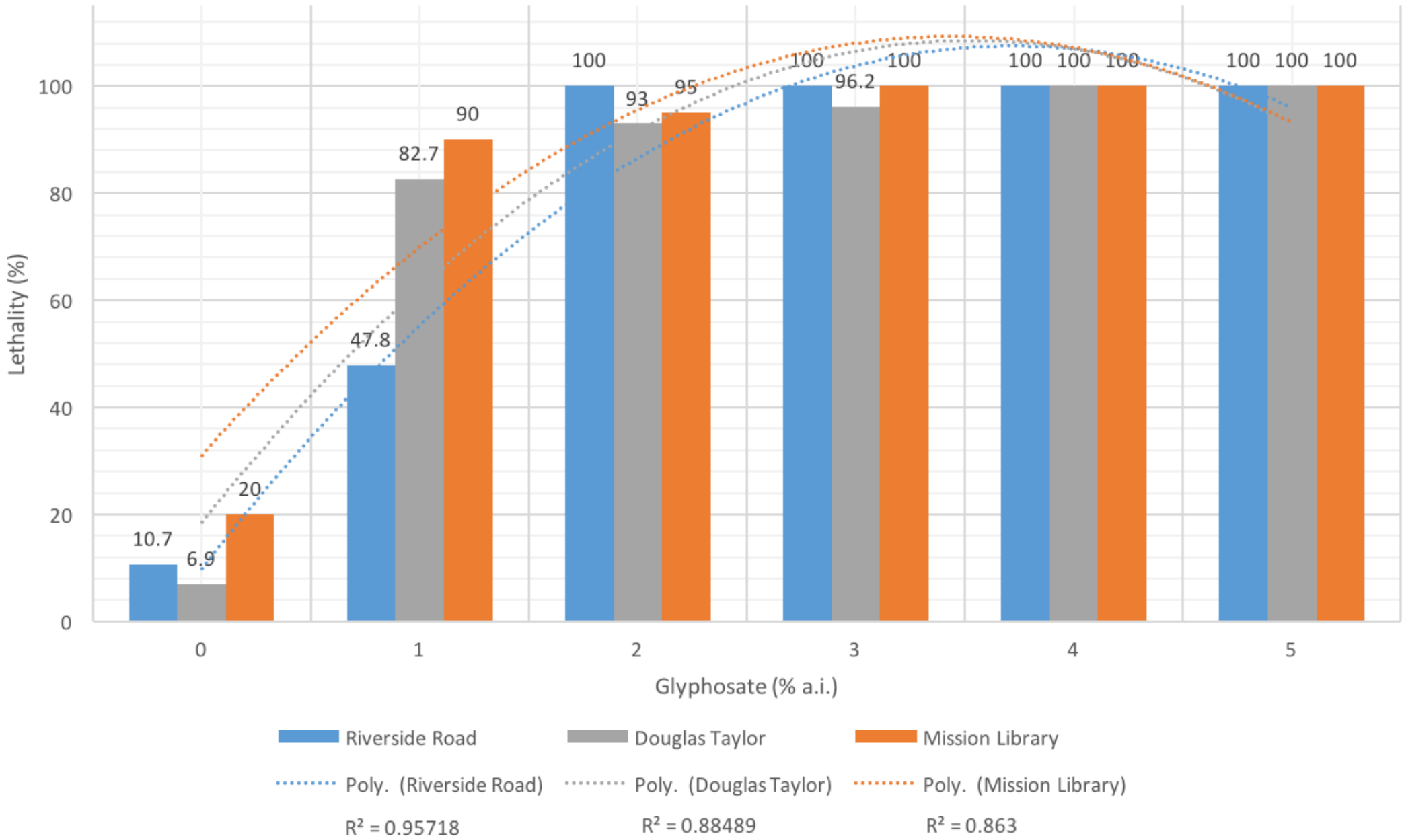
Glyphosate concentration (µM)	Survivorship rate	Survivorship Percentage
0	38/38	100%
5	39/39	100%
20	38/38	100%
80	40/40	100%
200	39/39	100%

Foliar Spraying on Shoots Emerging from Rhizomes



Knotweed mortality vs. active ingredient (isopropylamine salt) % of glyphosate using foliar spraying (21 days after application). Note however, that regrowth was seen in all groups treated with 1-5% a.i. glyphosate. Though the stalks were dead, the hardy fragment was unaffected and new shoots continued to grow.

In 2016 Strelau and Bogress grew Bohemian knotweed from rhizome fragments from 3 sites and subjected them to 5 doses of glyphosate


Lethality (%)
100
80
60
40
20
0
10.7
6.9
20
47.8
82.7
90
100
93
95
100
96.2
100
100
100
100
100
100
100
100
0
1
2
3
4
5
Glyphosate (% a.i.)
Riverside Road
Douglas Taylor
Mission Library
Poly. (Riverside Road)
Poly. (Douglas Taylor)
Poly. (Mission Library)
R² = 0.95718
R² = 0.88489
R² = 0.863

#5 HERBICIDAL CONTROL CHALLENGES

- Many restrictions on herbicide use near streams (e.g., especially in British Columbia)
- Minimum distance from stream for no pesticide use is 10 m, except for glyphosate, using selective techniques (e.g., stem injection)

Table 1. Overview of the main herbicides used for knotweed management in North America.

Mode of Action	Active ingredient	Timing
Group 2: ALS inhibitors	Imazapyr	Key growth stages (maximum height, flowering, presenescence)
Group 4: Synthetic auxins	Dicamba, chlopyralid, aminopyralid, picloram, 2,4-D	Early emergence
Group 9: EPSP synthesis inhibitor	Glyphosate	Emergent vegetation

#6 MANUAL CONTROL CHALLENGES

- Because of the extensive rhizome system, it is hard to completely remove knotweeds
- Soil disturbance tends to create more opportunities for knotweed to spread

Japanese Knotweed Treatment Site

We are attempting to eliminate
Japanese Knotweed (Fallopia japonica).

This is a test treatment site, using a non-chemical approach.

For this treatment to be effective the
black cover must stay intact for a period of time.

Please keep out of fenced area.

For more information please see:
www.pointpleasantpark.ca

HALIFAX
REGIONAL MUNICIPALITY

Knotweed patch cut down May 11, 2015 (Railway Site, Abbotsford, BC)

Recovered knotweed patch on June 8, 2015 (same site)


Extensive knotweed patch on a farm near Langley, BC
being attacked by my ecology students

#7 BIOLOGICAL CONTROL PROSPECTS

- Bourchier et al. (2013)* stated that "Because of the scale of the *Fallopia* spp. problem, biological control offers the best hope for ecologically sound and cost effective control."
- CABI leading worldwide biocontrol effort via the "Japanese knotweed alliance"
- In 2015 approval was given by CFIA to utilize the leaf-feeding psyllid, *Aphalara itadori* psyllid, in caged releases in Canada for overwintering studies in British Columbia, Alberta and Ontario (Rob Bourchier, pers. Comm.).

*Biological Control Programmes in Canada 2001–2012: 321-328

Table 3. Impact of regional and genetic differences on the effectiveness of management techniques utilized to control knotweeds (*Fallopia japonica*, F. *sachalinensis*, and *F.* × *bohemica*) in North America

Management technique	Impact of regional differences	Impact of genetic differences
Herbicidal control	Resources vary (e.g., funding level various according state or province)	The more variable *F.* × *bohemica* more likely to develop herbicide resistance
Mechanical control	Might be the only option in riparian areas in some jurisdictions	More effective against *F. sachalinensis* than *F. japonica* or *F.* × *bohemica*
Biological control	Limited caged releases of the psyllid *Aphalara itadori* approved for Canada as of 2015; not yet approved in the United States	Different strains of *A. itadori* might be required for different knotweed genotypes to optimize control

Knotweed continues to adapt, survive and amaze researchers…