Assessing the risks of biological control to crop and ornamental plant cultivars

Greg Lefoe
The problem
Silverleaf nightshade (SLN)
*Solanum elaeagnifolium*

- SLN is an American plant that is invasive in many parts of the world, including Australia.
- SLN directly competes with crops and pasture, and depletes soils of nutrients and moisture.
- All parts of the plant are toxic to livestock.
- SLN hosts pests and diseases of Solanum crops.
- **SLN is very difficult to control due to its extensive root system.**
Potential for biological control

• The North American leaf beetle *Leptinotarsa texana* is an effective and host-specific biocontrol of the weed in South Africa.
• Introduction of *L. texana* is proposed for Australia.
• Before introduction can be considered, the risk to native plants and crops must be assessed.
Risk to potato
Solanum tuberosum

No-choice experiments with naïve larvae
No-choice experiments with naïve larvae

Leaf damage

Solanum tuberosum “Nadine”
No-choice experiments with naïve larvae

Leaf damage

- 0.1 - 10%
- 10 - 50%
- 50 - 100%

Varieties:
- Argos
- Daisy
- Desiree
- Nadine
- Pontiac
- Russet Burbank
- Sebago
- Valor
Insects and cultivars

Relative susceptibility of two alfalfa cultivars to leafhopper damage, USA

Image: Ohio State University, https://slideplayer.com/slide/14619464/
Potato diversity

Potato is classified as *Solanum tuberosum*, however:

• Different studies recognize between one and 21 species.

• Modern potato cultivars are hybrids: the products of intensive breeding using *S. tuberosum* and 15 other members of section *Petota*.

• Caution is therefore recommended when extrapolating results from one or a few cultivars to a large crop or ornamental species complex.

Tuber-bearing species and varieties from Bolivia (top right), and *Solanum vernei* from northern Argentina (bottom right).

Initial recommendations

1) The method for selecting and prioritising cultivars should be described in sufficient detail to justify the final cultivar list,

2) The cultivar or cultivars selected for host-specificity testing should be named according to the Cultivated Plant Code (ISHS, 2016), and

3) Host-specificity testing data for individual cultivars should be reported or accessible.

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How are cultivars selected & prioritised?

Cultivar selection methods described in three biological control journals
(January 2015 - June 2019)

None = no description of the cultivars tested;
Partial = cultivars were listed for some test plant species but not others, and/or the method for selecting cultivars was not fully described;
Full = cultivars and selection method described.
Our assessment of current practice

• Most papers we examined either:
  o did not mention cultivars at all, even though they listed species that we know contain cultivars, or
  o provided an incomplete description of cultivars without explaining omissions.

• In most cases, if cultivars were listed then the criteria used to select cultivars were not described, or were incorrectly applied (in our judgement) or inconsistently applied.

• Results for individual cultivars were therefore absent or incomplete in most cases.

• Only one of 29 papers fully described the method for selecting and prioritising cultivars, and reported the results for each cultivar tested.
Developing a decision tool for selecting plant cultivars for host-specificity testing
Developing a decision tool
Developing a decision tool
An overview
Applying the decision tool to our potato case study
The global context

Very large > 4000 cultivars
The Australian context

Global list

Global cultivar (cv) list

Are any cv's present in or proposed for the area of introduction?

Yes

Initial cultivar list for the area of introduction

No

Don't test

100's cultivars in Australia?
Assessing past research
Exposure to risk

Distribution of silverleaf nightshade

Potato growing regions
1. Sampling using phylogeny
1. Sampling using phylogeny

light blue – French fry
red – crisping
dark blue – fresh

2. Sampling using sub-criteria
2. Selecting relevant sub-criteria

i. Economic or amenity importance.

ii. Availability of cultivar for testing.

iii. Known or potential susceptibility to other pests and diseases.

iv. Use of different rootstocks.

v. Cultivar type or plant breeding approach.

vi. Other – ie. protection from insect attack, plant chemistry or morphology, same breeding program or probable lineage.
2. Applying our sampling strategy

light blue – French fry
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Was the decision tool useful in our case study?

• From 1000’s of cultivars grown worldwide, we have selected 12 cultivars relevant to the Australian context, of which only 11 need to be tested.

• And yet, by diversifying our sampling we have improved the chances of detecting susceptible cultivars if they are present.

• And, we have considered the values of important stakeholder groups.
How many cultivars should we test?

• From 1000’s of cultivars grown worldwide, we have selected 12 cultivars relevant to the Australian context, of which only 11 need to be tested.

  – We now have a draft list that is feasible to test, but which can be scrutinised and updated, and

  – We are also able to respond to long cultivar “wish lists” that don’t inform risk analysis.
Can the decision tool be applied to other crop and ornamental species?

• From our case study and scenario testing, we can demonstrate that the decision tool is:
  - easy to use,
  - can account for uncertainty,
  - is adaptable to different species, and
  - is suitable for both small and large cultivar groups irrespective of the complexity of the group.

• We argue that our decision tool, if adopted by weed biological control researchers, will result in more transparent, defensible and reproducible cultivar selection practices.
Today’s discussion:

• Is this a useful contribution to biological control risk assessment?
• Are there flaws in reasoning or in the decision tool itself?
• Can you think of examples where this approach wouldn’t work?
• Can you propose additional sub-criteria?
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