AGRINOVA
RECHERCHE ET INNOVATION EN AGRICULTURE

DEVELOPMENT AND EXPERIMENTATION OF A TECHNOLOGY TO EVALUATE NEW RESISTANT POTATO VARIETIES TO COMMON SCAB

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CONTEXT

In order to produce tubers acceptable for consumers, potato varieties must be free (or almost) of common scab caused by the bacteria *Streptomyces scabies*. While there are few effective and affordable methods to control this disease, many producers choose to plant resistant varieties. For the breeder and producer, Peter VanderZaag from Sunrise Potato Storage Ltd., the evaluation of the common scab tolerance of his new varieties consists in doing trials in an infested field. However, the results obtained with this technique were really inconstant from year to year because this disease can be very heterogeneous inside of the field and also because the infection is highly affected by the precipitations during the growing season.

Agrinova proposed to Sunrise Potato Storage to develop and test different procedures inside a greenhouse in order to create a protocol that will determine the tolerance or susceptibility of new potato lines to common scab.

OBJECTIVE

The objective of this project is to develop a reliable and reproducible protocol for the evaluation of potato lines for tolerance to common scab. Specifically, the project is based on the development, characterization and use of various production substrates with and without *S. scabies*, and to test their performance on different potato varieties known for their tolerance or susceptibility to *S. scabies*.

METHODOLOGY

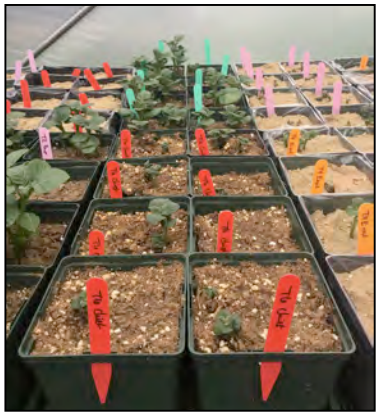
The project was carried out in a greenhouse complex at the Agrinova potato research site in Sainte-Croix, Quebec.

The experimental treatments put in place were:

Treatment 1: soil with the addition of potato peels with common scab. Potatoes with common scab lesions were peeled and 5 pieces of approximately 10 cm^2 were placed around the healthy seed in the pot. Substrate was made of all-purpose soil mix, Agro-Mix, black earth and sand in a proportion of 2:2:1.

Treatment 2: infected soil imported from a field in Alliston (Ontario) where several strains of *S. scabies* were introduced. This soil was mixed with Agro-Mix in a proportion of 3:1 before filling the pots.




Treatment 3: sterilized sand with the addition of *S. scabies* at a concentration of 0.05. Sand bought in bulk was sterilized in an oven. Then put in an aluminum pan of 3 inches depth, sand remained in the oven at 450°C for 45 minutes. Once the sand temperature cooled down, inoculum of *Streptomyces scabies,* prepared by Dr. Nathalie Beaudoin at the Biology Department at Sherbrooke University, was incorporated at a proportion of 20:1. Vermiculite was also added to the mix for soil aeration.

Treatment 4: sand sterilized with the addition of *S. scabies* at a concentration of 0.025.

Treatment 5: sand sterilized with the addition of *S. scabies* at a concentration of 0.0125.

Treatment 6: all-purpose soil, Agro-Mix (control).

For each treatment, five known varieties for their susceptibility or tolerance to common scab were tested. Yukon Gold (very susceptible), Chieftain (susceptible), Envol (susceptible), Superior (tolerant) and Goldrush (very tolerant).

All treatments were replicated four times in a complete randomized block. Each treatment consisted of 8 pots in a tray. The size of the pot was 6 inches high by 5 inches wide.

During the week of July 7th, treatments were prepared and potato seeds planted. Potato plants developed for a total of 12 weeks inside the greenhouse.

In order to maximize tuber infection with common scab, a rigorous control of irrigation was in place, as limited water in soil promotes the proliferation of the *S. scabies*. Each irrigation consisted of approximately 50 ml of water in each pot and a total of 18 irrigations were made during the 12 weeks. Fertilizer (20-20-20) was applied every two weeks at a rate of 3g/l.

Common scab rating on tubers was achieved on October 19th. Ratings were based on lesion coverage (%) and lesion type (pitted or not) according to the Michigan University rating scale[1]. Rating scale from 0 to 5 is showed at Table 1.

Table 1. Rating scale used to classify the severity of common scab infection on potato tubers

	Scab Severity Rating Criteria		
Rating	Scab lesion percent % surface area	Pitted lesion percent % surface area	Depth of pits mm
0	0	0	0
1	1-10	0	0
2	11-25	0	0
3	26-50	1-5	< 1
4	> 50	6-25	> 1
5	> 50	> 25	> 1

From: Driscoll and *al*., 2009

RESULTS

Plant development

- During the experiment, differences in plant development were observed between the treatments. Plants treated with *Streptomyces scabies* inoculum (T3, T4 and T5) were considerably smaller compared to the other plants.
- Tubers harvested from the T3, T4 and T5 treatment were also smaller than the other treatments.

Common scab evaluation

Treatment 1 – Potato skin

- Tubers harvested from the Treatment 1 (potato skin infected by common scab), showed very few lesions for three of the varieties, namely Superior, Envol and Goldrush (Table 2).
- Yukon Gold was significantly affected compared to the other four varieties with a rating of 2.56 (on 5).
- There's no significant difference between the other four varieties, including Envol/Chieftain and Goldrush which normally presents opposed response to scab.

Treatment 2 – Alliston soil

- Compared to the T1, there's more difference between the varieties for the treatment using the Alliston soil.
- Chieftain presents significantly more lesions than the Goldrush variety. However, there's no significant differences between Chieftain, Envol, Yukon Gold and Superior.
- Yukon Gold, which is usually the most susceptible varietiy among the five tested, is in third position. This results suggest that the innoclum of *S. scabies* is not homogeneous in the soil and tubers were underrated.

[1] Driscoll, J., J. Coobs, R. Hammerschmidt, W. Kirk, L. Wanner and D. Douches, 2009. *Greenhouse and field nursery evaluation for potato common scab tolerance in a tetraploid population*, American Journal of Potato Research, 86: 96-101.

Treatment 3 – Inoculum of Streptomyces scabies (0.05)

- The highest rate of inoculum (0.05) allowed a dissociation between the susceptible and the tolerant varieties. Yukon Gold and Chieftain are highly susceptible compared to Superior and Goldrush.
- However, ratings are very high for all the varieties and this can cause undesirable effects as new potato lines could be discarded. For example, if a new line generated a score of 2.80 (like the Superior), it will probably be categorized as susceptible, while Superior is considered tolerant.

Treatment 4 – Inoculum of Streptomyces scabies (0.025)

- Significant differences were obtained between the varieties with the S. scabies rate 0.025. Yukon Gold and Chieftain were significantly more affected than Goldrush.
- Rating assigned to each one of the varieties is close to what it observed in a commercial field with common scab.

Treatment 5 – Inoculum of Streptomyces scabies (0.0125)

- The lowest rate of inoculum generated significant differences among the varieties and a good distinction between the susceptible (Yukon Gold, Envol) and tolerant (Superior, Goldrush) ones.
- However, the rating assigned for the three most susceptible varieties, (Yukon Gold, Chieftain and Envol) are quite low. Without statistic analysis, it could be difficult to dissociate the susceptible varieties from the tolerant.

Treatment 6 – All-purpose soil Agro-Mix (control)

- No significant difference was oberved between all the varieties and all values are very low.
- Even if it was initially thought that this treatment would not generate lesions for either of the varieties, somes tubers were affected by the common scab. Three possibilities can explain this: the potato seeds were not totally exempted of common scab; a cross-contamination happened during the treatments production or the irrigation; the soil was not free of S. scabies.

Table 2. Common scab severity under the differents treatments for the five varieties

T1 – Potato skin

Variety	Severity
Yukon Gold	2.56 a
Chieftain	1.34 b
Superior	0.73 b
Envol	0.66 b
Goldrush	0.66 b

T2 – Alliston soil

Variety	Severity
Chieftain	2.06 a
Envol	1.34 ab
Yukon Gold	1.12 ab
Superior	0.98 ab
Goldrush	0.40 b

T3 – *S. scabies* (0.05)

Variety	Severity
Yukon Gold	3.91 a
Chieftain	3.80 a
Envol	3.70 ab
Superior	2.80 b
Goldrush	1.25 c

T4 – *S. scabies* (0.025)

Variety	Severity
Yukon Gold	3.41 a
Chieftain	2.39 ab
Envol	2.31 b
Superior	2.11 b
Goldrush	0.73 c

T5 – *S. scabies* (0.0125)

Variety	Severity
Yukon Gold	1.83 a
Envol	1.56 ab
Chieftain	1.14 abc
Superior	0.77 bc
Goldrush	0.18 c

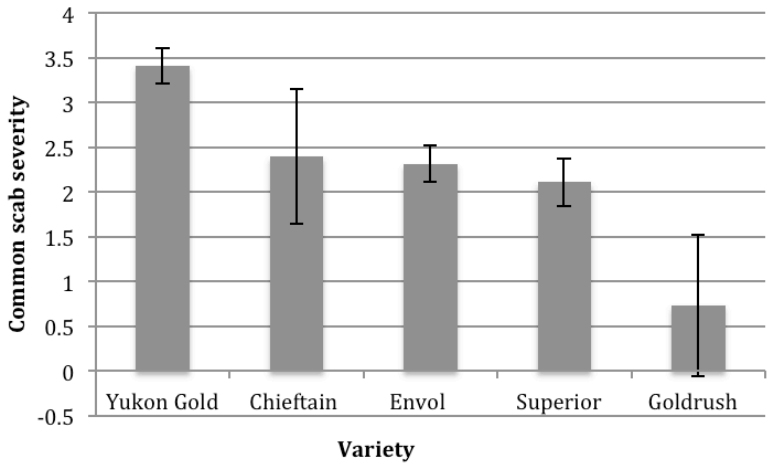
T6 – Agro-Mix

Variety	Severity
Chieftain	0.72 a
Yukon Gold	0.16 a
Goldrush	0.03 a
Envol	0.00 a
Superior	0.00 a

Data with a different letter on the same row are significantly different (P < 0,05) according to the Tukey test

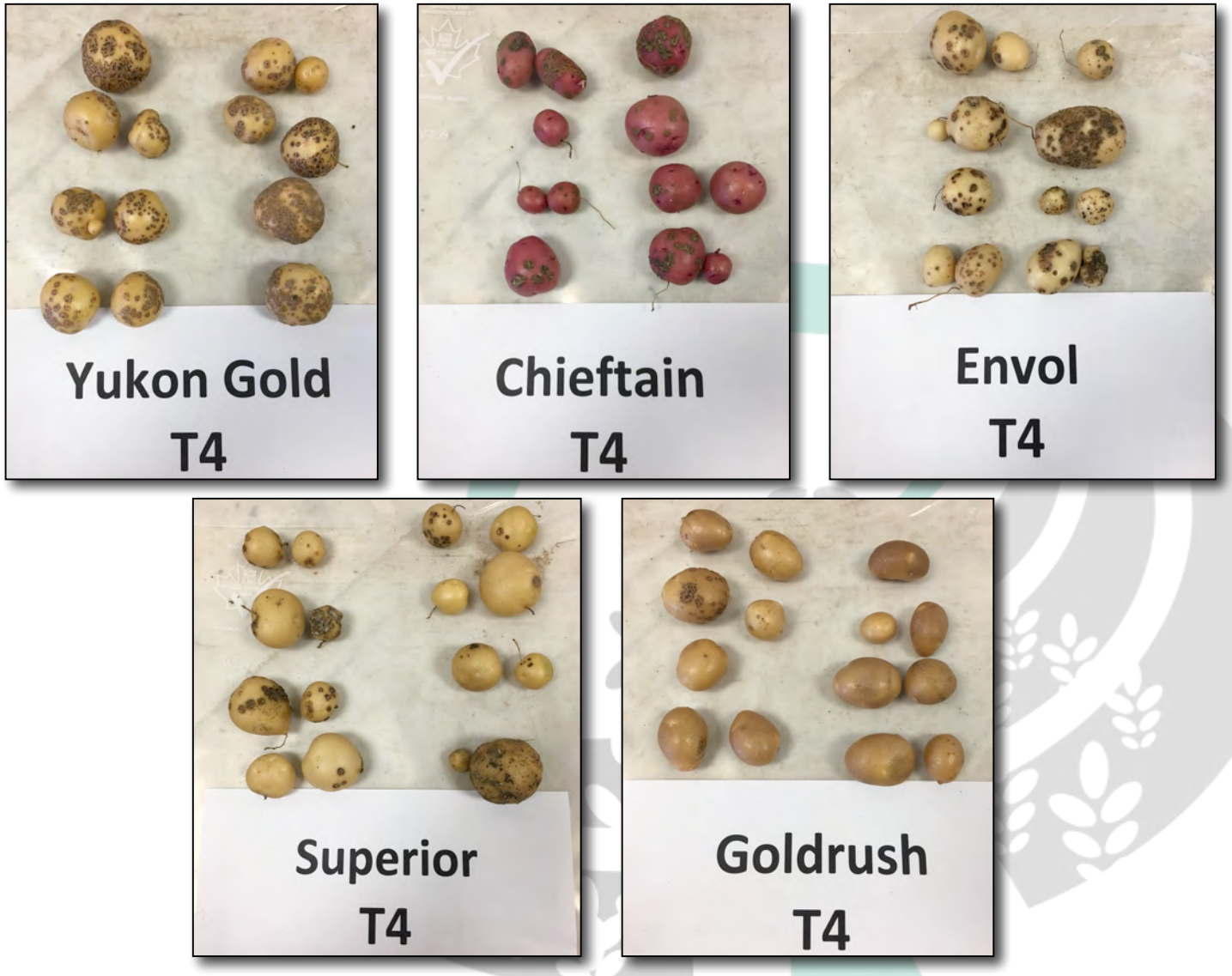
Treatment 4

- Substrate inoculation of *S. scabies* in a proportion of 2.5% shows the best result to determine the tolerance/susceptibility of potato to common scab.
- As demonstrated in Figure 1, standard deviation (SD) is low for Yukon Gold, Envol and Superior. On the other hand, Chieftain and Goldrush generated a higher SD because of a greater variation in the rating.
- These results suggest that several tubers should be assessed in order to have reliable data. It's to be pointed out that 4 replicates and a total of 32 tubers were measured in this trial.



Variety	Yukon Gold	Chieftain	Envol	Superior	Goldrush
Mean	3.41	2.39	2.31	2.11	0.73
S.D.	0.20	0.75	0.21	0.27	0.79

Figure 1. Common scab severity for the five varieties under the Treatment 4



HILIGHTS

- Treatment 1 (potato skin infected by common scab) generated very few lesions on tubers harvested excepted for the Yukon Gold. No significant difference between varieties that normally present opposed response to scab was obtained.
- Even if the ratings are higher and there's more distinction between the varities than the T1, Treatment 2 (Alliston soil) didn't generated a significant difference between 4 of the 5 varieties tested including the most susceptible and the most tolerant one.
- Treatment 3, 4 and 5 (*S. scabies* inoculum) has resulted in a significant amount of work regarding the preparation of the treatment, namely the sterilization of the sand and the inoculum preparation by the university that took almost 7 weeks because the first attempt of bacteria proliferation didn't work.
- Dissociation can be made between the tolerant and the susceptible varieties for the treatment 3 with the higher rate of inoculum (5 %), but it generated a lot of lesions for all varieties. On the opposite, for the lowest rate of inoculum (T5), the rating assigned to the three most susceptible varieties, (Yukon Gold, Chieftain and Envol) were quite low.
- Treatment 4 resulted in the best distinction between the susceptible and the tolerant varieties with data similar to what is observed in the field.
- Because of the difficulty to obtain a perfectly homogeneous susbtrate inoculate with *S. scabies*, several replicates should be achieved and numerous tubers should be assessed in order to have a good representativeness.

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