Project report for SSCR-Potatoes

***Project title*:**

Does haulm pulling influence (directly or indirectly), incidence and severity of blackleg in subsequent progeny crops?

Applicant(s):

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Background to the project

Blackleg (chiefly due to Pectobacterium spp.) remains the most serious threat to high grade seed potato production in Scotland, and downgrades due to blackleg representing a severe loss of investment for Pre Basic seed growers.

The perception amongst growers is that issues with blackleg have worsened since the use of sulphuric acid as a desiccant was halted. Decisions around haulm destruction are thought to play a key role in subsequent blackleg risk.

Chemical desiccation post-sulphuric acid has relied heavily on diquat, and there is an additional concern amongst growers that haulm destruction using alternative PPO based herbicides (which are slower acting) may increase the risk of disease development, both blackleg and gangrene are frequently mentioned.

Some seed growers have initiated manual removal of plant stems and foliage (haulm pulling) as a method of haulm destruction. Anecdotally, this has markedly reduced blackleg incidence in subsequent field generations, and there is some good observational data from on farm trials in support of this, but there is a need for trials with rigorous experimental design to establish if further work is merited.

Aims and objectives

1. Establish if haulm pulling in high grade seed crops leads to appreciable reductions in:
    a. Bacterial (*Pectobacterium ssp.*) loading of tubers at the following times:
        i. After harvest of a PB2/FG crop.
        ii. After storage of a PB2/FG2 crop
    b. Development of blackleg in PB3/FG3 daughter crops.

2. Compare the risk of disease transmission due to haulm destruction methods <u>currently available</u> to growers in Scotland.

Research results

Two Aberdeenshire based growers agreed to host the multiyear trials. One of each grower's pre-basic seed crops (PB2) was selected as the tracked crop. At Farm A[1] the cultivar was Desiree and at Farm B, Maris Bard. In both cases the growers explained that blackleg often occurs in these varieties within their production systems. A summary of the assessments conducted can be found in the appendix (Item 1).

Site plans can be found as Item 2 in the appendix. In both cases haulm pulling by hand was compared to the "farm standard" method of haulm destruction. At Farm A this is a sequence of PPO inhibitor sprays, and the Farm B standard is mechanical pulverization ("flailing") followed by a PPO inhibitor spray (treatment details can be found in the appendix, Item 3). No blackleg was found in the Farm A parent (Desiree), 25 blackleg plants were rouge from the parent at Farm B (Maris Bard).

Blackleg is a sporadically occurring disease and a challenging field trial subject, so replication and large crop sections were desirable. Each of the PB2 crops were divided into sections (effectively blocks), and half of each section was haulm pulled; the other subsection underwent the farm standard haulm destruction method (allocation was randomized, see appendix Item 2). At Farm A each subsection consisted of a single bed approximately 150m in length, and at Farm B 70m sub-sections of adjacent beds. Sub-sections were lifted by the growers into individual boxes to preserve identity. These were then used as input seed for "daughter sections" in 2021.

The growers did not grade the boxes and they were replanted in 2021 "as dug" to avoid cross-contamination. Tuber samples (100 per subsection) were drawn from each box at harvest and immediately before planting. Loading of pectolytic bacteria from skin peel and stolon end plug was determined from these samples using CVP-dilution plating. Immediately following harvest, all samples were below the limit of detection for contamination with soft rotting bacteria. At planting, contamination was found at both Farm A and B's stocks, but at very low levels. In both cases greater numbers of pectolytic bacteria were found in stolon end plug from non-haulm pulled plots. Data are summarized as Item 4 in the appendix.

Tubers were visually inspected for disease incidence. No other tuber diseases which could have been influenced by haulm destruction were present at applicable levels in the harvested tubers which should be reassuring to growers. Common scab was present at relatively high levels for both crops, but infection occurs much earlier in the season (i.e., at tuber initiation) and will not have been influenced by haulm destruction. Very few rots were found in either crop, and there were no differences between haulm destruction methods.

In 2021 tubers from all boxes were replanted in marked "daughter sections" and rogued three times throughout the season. At both sites, blackleg symptomatic plants were found from the second assessment time onwards (appendix, Item 5). At Site A, mean number of blackleg plants found was 0.5 in sections from PPO desiccated parents and 2.5 for haulm pulled parents ($p = 0.02$, χ^2 test, however 44% of the symptomatic plants occurred in a single haulm pulled replicate). At Site B there was no statistically significant differences in blackleg plant counts between treatments ($p = 0.55$, χ^2 test), with on average 8 blackleg plants in sections from a pulverized parent and 9 blackleg plants in sections from a haulm pulled parent.

The two daughter crops represent contrasting situations of moderate and low disease incidence. The slight increase in blackleg development from haulm pulled parents at Site A is likely spurious as disease incidence was low (18 blackleg plants across the crop). Site B has much higher disease pressure (100 symptomatic plants in total).

Disappointingly, the data from this trial did not provide strong evidence that haulm pulling lowers blackleg risk. However, this result is at odds with suggestions from previous work and with growers own on-farm observations of blackleg risk following haulm-pulling. Conditions for haulm destruction where almost ideal in 2020, and in general relatively little blackleg developed in Scottish crops in 2020 and 2021. Although little bacterial loading was detected. The lower stolon-end contamination in haulm pulled plots is interesting and merits further investigation.

[1] Note the term "Farm" is used in a very general sense – crops may have been sited on rented land.

Outcomes

The results from the field in this project did not match initial expectations. The main objective was to establish an effect size for reduction in blackleg risk for haulm pulling, in order to stimulate investigations into mechanisms, or as an incentive for mechanisation.

The lack of observed benefit from haulm pulling could be put down to a two consecutive low disease pressure seasons and benign conditions at haulm destruction in 2020 and 2021. Alternatively, it may be that method of haulm destruction has little impact on subsequent blackleg development, in which cause growers can be reassured that their chosen method of haulm destruction does not increase their exposure to risk. At face value the PPO inhibitor sprays had lowest in-season blackleg development.

The main unanswered question from this work is if haulm pulling has any benefit on reducing blackleg risk in a wet season. Data from haulm pulling in wet conditions (simulated or natural) are required before a benefit can be discounted.

A large amount of assistance was received by both growers who host and conducted much of the trial work. They also took a risk by hosting a disease trial within their high-grade crops.

Trials and laboratory staff at SRUC Aberdeen provided invaluable assistance in collecting the data.

Next steps

Both growers have expressed a strong interest in further blackleg and/or haulm destruction trial work.

Although the trial outcomes were not as clear-cut as hoped, they do demonstrate that on-farm multiyear potato trial work is feasible.

We are also ware of several commercial engineering companies who are developing new mechanical methods of haulm destruction (including pulling). These have been approached to gauge interest in assessing disease risk in general and blackleg in particular.

Appendix

1. Table of assessments (all assessments conducted at both farms)

Assessment	Date
1. Blackleg symptoms at Haulm Destruction	Aug. 2020
2. Bacterial count at lifting (skin peel & stolon end plugs)	Aug. 2020
3. Disease assessment (surface and rots)	Jan. 2021
4. Bacterial counts at planting (skin peel & stolon end plugs)	May. 2021
5. Blackleg symptom development during growing season	June – Aug. 2021

2 – Field layouts

2.1 Farm A 2020 (parent sections)

Not to scale. Each subsection one bed wide (1.83m) and 150m in length.

Note that two additional treatments were included as demonstrations by the grower (Slatex desiccation and Flailing + PPO inhibitor).

F	*Flail + PPO*
4a	PPO inhib. sequence
4b	Haulm pulled

1s	*Saltex*
3a	Haulm pulled
3b	PPO inhib. sequence

2a	Haulm pulled
2b	PPO inhib. sequence

1a	PPO inhib. sequence
1b	Haulm pulled
1s	*Saltex*

2.2 Farm A 2021 (daughter sections)

Not to scale

3a	Haulm pulled parent
3b	PPO inhib. sequence parent
2b	PPO inhib. sequence parent
2a	Haulm pulled parent
1a	PPO inhib. sequence parent
1b	Haulm pulled parent
1s	*Saltex parent*
F	*Flailed parent*
2s	*Saltex parent*
4b	Haulm pulled parent
4a	PPO inhib. sequence parent

2.3 Farm B 2020 (parent sections)

Not to scale. Each subsection one bed (i.e. row rows, 1.83m) wide and 70m in length.

1a	Haulm pulled	1b	Flail and spray
2a	Flail and spray	2b	Haulm pulled
3a	Flail and spray	3b	Haulm pulled
4a	Haulm pulled	4b	Flail and spray
5a	Flail and spray	5b	Haulm pulled
6a	Haulm pulled	6b	Flail and spray

2.4 Farm B 2021 (daughter sections)

Not to scale

2a	Flail and spray parent	3
2b	Haulm pulled parent	4
1b	Flail and spray parent	2
1a	Haulm pulled parent	1
3a	Flail and spray parent	5
3b	Haulm pulled parent	6
6b	Flail and spray parent	12
6a	Haulm pulled parent	11
4a	Haulm pulled parent	7
4b	Flail and spray parent	8
5b	Haulm pulled parent	10
5a	Flail and spray parent	9

3. Haulm destruction details for parent sections (2020)

3.1 Farm A

Haulm Pulled Sections	Farm Standard (PPO inhibitor desiccated)	
05 August 2020 Plants pulled up by hand *20°C – Slightly overcast. Little wind.*	T1.	06 August 2020 carfentrazone-ethyl (as Spolight Plus, FMC Agro) @ 1.0 L/ha in 400 L/ha H_2O *17°C – Fair. Little wind.*
	T2.	13 August 2020 pyraflufen-ethyl (as Gozai, Belchim Crop Protection) @ 0.8 L/ha + methylated rapeseed oil (as Toil, Interagro) @ 1.5 L/ha in 400 L/ha H_2O *18°C – Slightly overcast. Gentle breeze.*

3.2 Farm B

Haulm Pulled Sections	Farm Standard (Pulverized and PPO inhibitor desiccated)	
30 July 2020 Plants pulled up by hand *16°C – Cloudy, Moderate breeze.*	F	31 July 2020 Mechanically pulverised 20*°C – Sunny, Calm.*
	T1	03 August 2020 carfentrazone-ethyl (as Spolight Plus, FMC Agro) @ 1.0 L/ha in 300 L/ha H_2O *17°C – Fair, Gentle breeze*

4. Bacterial counts (via CVP dilution plating)

4.1 Farm A – pre planting 2021 sample

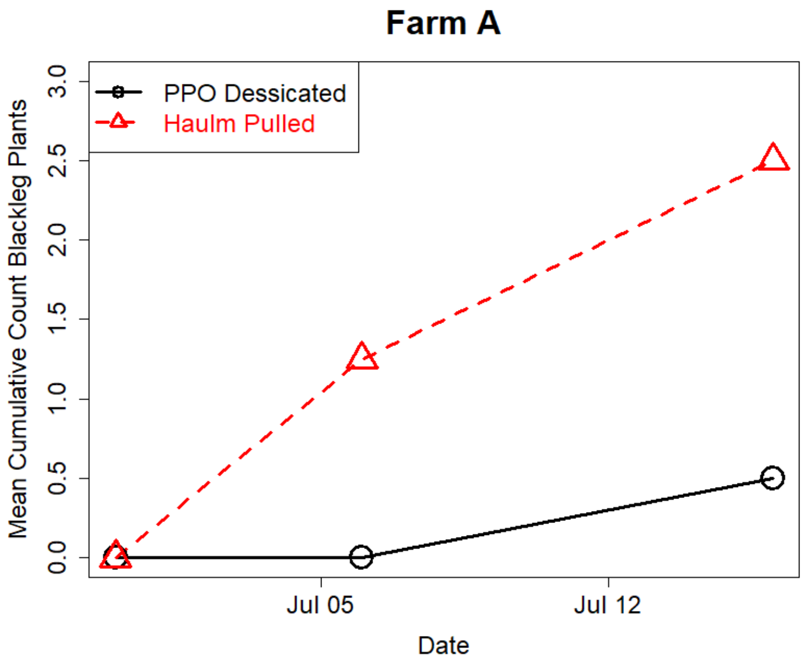
	MPN pectolytic bacteria / 100 mL [sections where contamination detected]	
Parent sections	**Tuber periderm**	**Stolon end plugs**
Haulm Pulled	0 [0/4]	0 [0/4]
PPO inhib. desiccated	0 [0/4]	15.5 [2/4]

4.2 Farm B – pre planting 2021 sample

	MPN pectolytic bacteria / 100 mL [sections where contamination detected]	
Parent sections	**Tuber periderm**	**Stolon end plugs**
Haulm Pulled	0 [0/6]	1.0 [1/6]
PPO inhib. desiccated	0.5 [2/6]	2.3 [1/6]

5. Blackleg development in-season

5.1 Farm A



5.2 Farm B