

Modelling effects of climate change on the over winter survival of *Phytophthora infestans* in potato tubers in Idaho.

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INTRODUCTION

Over the past 40 years, climatic conditions in Idaho have been becoming more conducive for the initiation and development of potato late blight epidemics. Potato late blight epidemics are initiated from mycelium of *Phytophthora infestans*, which survive over winter in infected potatoes left behind buried in the field after harvest (volunteer) and waste (cull) potatoes (Fig. 1). The dry Idaho climate and cold winters are not usually conducive for the overwinter survival of volunteer potatoes. However, with the recent trend for warmer winters, more volunteers and cull pile potatoes are surviving the winter and acting as potential sources of inoculum in the spring. Studies have shown that mycelia of newer genotypes of *P. infestans* (e.g. US-8 and US-23) are becoming more tolerant to colder temperatures and are tolerant to -3°C for up to three days continuous exposure. Tubers of most varieties appear to breakdown after exposure to -3°C for about one day. Winter (November to April) soil temperature data was collected from nine AgriMet weather stations located in the main potato growing regions of Idaho in the Snake River Valley analyzed to determine the effect of winter soil temperatures on the survival of volunteer potatoes over winter for the past 25 years.



Figure 1. A field planted with corn that has been overrun by volunteer potatoes that were left behind at harvest and survived the winter.

MATERIALS AND METHODS

Hourly soil temperature data was collected from the nine AgriMet automated weather stations in southern Idaho that have soil temperature probes at 5 and 10 cm depth.

Data was collected for the winter months from November 1st through March 31st from 1991 to 2015. Although data was not available for all stations going back to 1991. A Perl script was written to parse the AgriMet data (which is available online as text files) and enter it into a MySQL database. A second program then queried the database to determine the total cumulative hours between November and March that were under -3°C . This data was then analysed according to the following rules to determine the risk of volunteer potatoes surviving in soil overwinter in a particular winter season.

- If soil temperatures were below -3°C for more than 120 h between November 1st and March 31st at 5 and 10 cm depths then the risk of tuber survival was considered low.
- If soil temperatures were below -3°C for less than 120 h at 10 cm depth and greater than 120 h at 5 cm depth then there was a moderate risk of tuber survival.
- If tubers were exposed to temperatures below -3°C for less than 120 h at 10 cm depth and less than 120 h at 5 cm depth then there was a high risk of tuber survival.

RESULTS AND DISCUSSION

The number of years out of the past 25, where the risk of volunteer survival was categorized high, was greater than the number of years where the risk was categorized as low (Table 1). It is only in the past 5 years (except 2015) that we have had several years where the risk of survival was categorized as low.

Table 1. The number of years from 1991 – 2015 that the risk of volunteer potato survival over winter was categorized as either low, moderate or high according to the volunteer survival model.

Station	Low	Moderate	High
Aberdeen	4	1	19
Ashton	3	0	21
Fairfield	3	0	12
Malta	9	0	16
Picabo	7	1	14
Parma	4	0	20
Rupert	9	1	15
Rexburg	4	0	21
Twin Falls	0	2	23

Analysis of cumulative soil data at 5 and 10 cm depths over the past 25 years showed that for most stations the number of hours that the soil temperature was below -3°C has actually been increasing (Figs. 4a and b), except for 2015 where none of the stations had more than 10 cumulative hours below -3°C .

These results demonstrate the increased potential for volunteer potatoes to survive over the winter in soil even in the most northerly potato growing regions in Idaho. Late blight is known to over winter in potato tubers intended for replanting as seed, but the disease may also be incubated in volunteer and cull potatoes. The increased probability of volunteer and cull potatoes surviving the winter in Idaho increases the chances of them acting as a source of infection for the establishment of late blight epidemics.

foci, disease gradients, and infection sources. *Phytopathology* 88: 754-763.

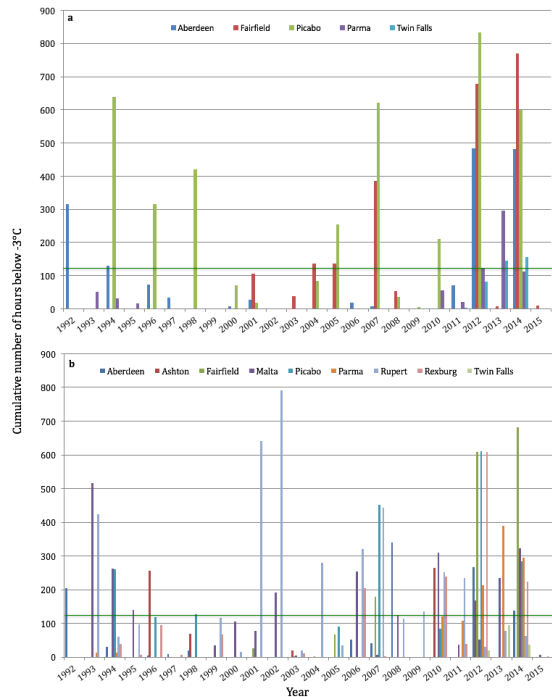


Figure 4. The cumulative number of hours the soil temperature at 5 and 10 cm was below -3°C over the winter months between November 1st and March 31st, from 1992 to 2015. Data was collected from nine AgriMet weather stations with soil temperature probes at (a) 5 and (b) 10 cm depths. Note that not all stations had soil probes at 5 cm and data for Fairfield didn't begin until 2001. The green line represents the threshold (120hrs) for low risk of volunteer tuber survival.

SUMMARY

- Milder winters in Idaho have become more prevalent over the past 40 years leading to the greater chance of infected tubers surviving in soil over winter.
- The number of years between 1991 and 2015, where the risk of volunteer survival was categorized high, was greater than the number of years where the risk was categorized as low.
- Analysis of cumulative soil data at 5 and 10 cm depths over the past 25 years showed that the number of hours that the soil temperature was below -3°C has actually been increasing.
- Studies have shown that mycelia of newer genotypes of *P. infestans* (e.g. US-8 and US-23) are becoming more tolerant to colder temperatures and are tolerant to -3°C for up to three days continuous exposure.

REFERENCES

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