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Overwintering of Late Blight in Idaho in Volunteer and Cull Potatoes

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Volunteer potatoes

During recent epidemics of late blight late in the 2013 and 2014 growing seasons there was speculation as to the source of these outbreaks and debate as to the relative importance of overwintering sources of inoculum. *Phytophthora infestans*, the causal agent of late blight, overwinters in potato tubers intended for planting as seed, but may also be harbored in waste or cull potatoes, or in late blight-infected volunteer potatoes left behind in the field during harvest the previous season.

Volunteer potatoes have become an important perennial weed in many potato growing regions. Researchers in Washington have reported that up to 1,122,000 tubers per acre are returned to the soil after harvest. Potato sprouts emerge from overwintered tubers and grow rapidly in the spring. This rapid growth combined with the tuber's ability to re-sprout makes them very difficult to control, even with multiple control measures. Studies with field corn showed that when volunteer potatoes were not controlled corn yields were reduced up to 62%. Volunteer potatoes also act as hosts for a number of important pests and diseases, including late blight, Colorado potato beetle, *Potato leafroll virus*, *Potato virus Y* and nematodes such as *Paratrichodorus allius* (the nematode that transmits *Tobacco rattle virus*, the causal agent of corky ringspot disease).

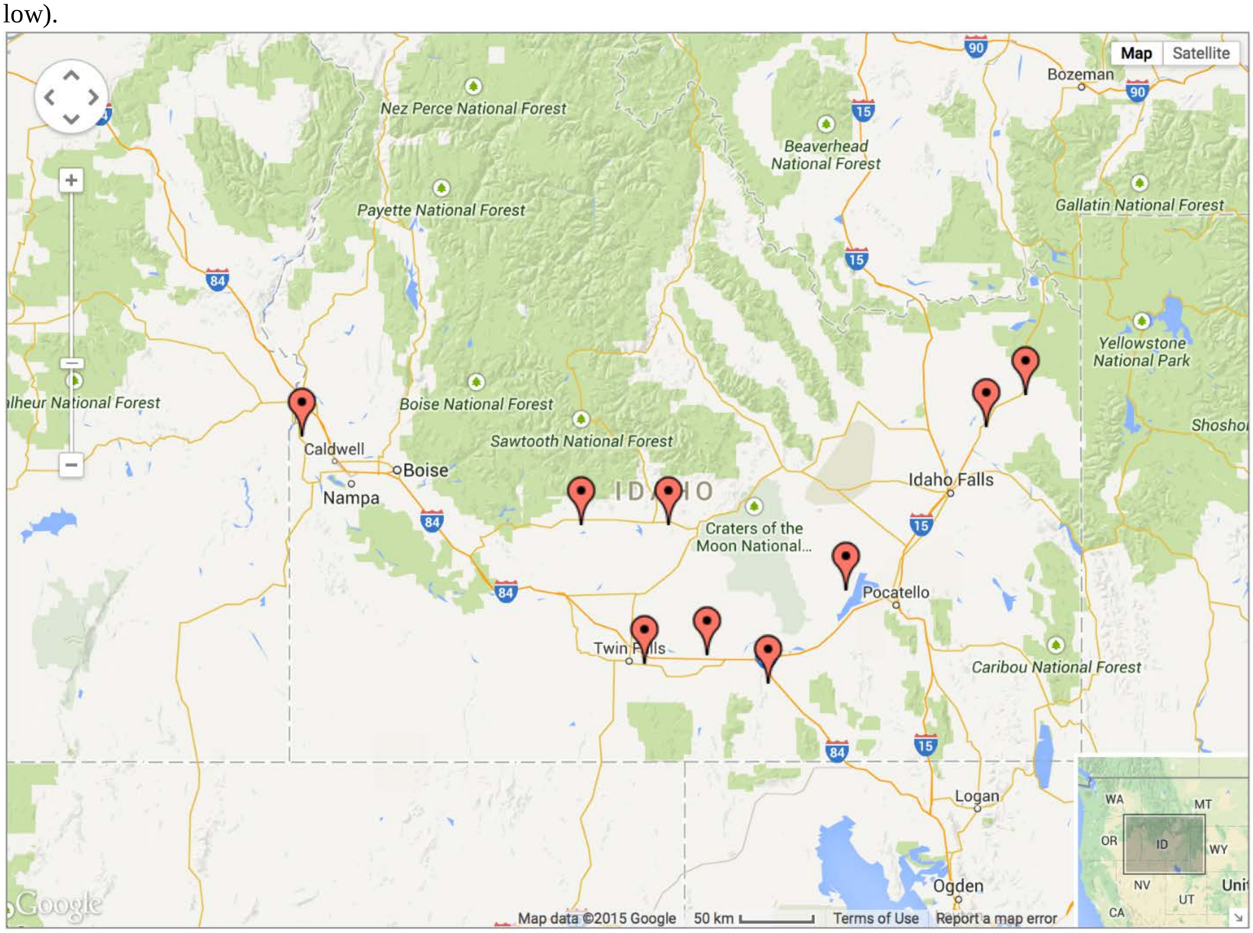
Potato tubers are susceptible to cold injury and in the past tubers left in the soil after harvest would likely be killed by freezing soil temperatures during winter. Tuber death resulting from cold injury is usually caused by freezing of intracellular water in the tuber tissue. Field trials conducted in Washington state showed that when soil temperatures at tuber depth reached 27°F or lower, extensive tuber death occurred.

Many interacting variables including meteorological factors and increasing tolerance of *P. infestans* to colder temperatures represent a serious situation for the potato industry in the Pacific Northwest (PNW). Winters in the PNW are becoming warmer which may favor survival of volunteer potatoes and cull potatoes over winter. With the recent trend for warmer winters, more volunteers and cull pile potatoes are surviving the winter and acting as sources of disease inoculum in the spring. Recent studies have shown that mycelia of newer genotypes of *P. infestans* (e.g. US-8 and US-23) are becoming more tolerant to cold temperatures and are tolerant to 27°F for up to three days continuous exposure. Studies at Michigan State University (MSU) have shown that the tubers of most cultivars appear to break down after exposure to 27°F for about one day. Thus, the monitoring of winter soil temperatures may enable growers to accurately estimate the potential for survival of volunteer plants over winter and thus help to estimate the risk of an epidemic of late blight initiated from volunteer potatoes or cull piles. We have developed a model that predicts the likelihood of tuber survival over the winter based on soil temperatures at 2 and 4 inches between November 1st and March 31st. (see: www.lateblight.org/volunteer-risk.php)

- If tubers were exposed to temperatures below 27°F for more than 120 h between 1 November through 31 March at 4 and 2" depth then the risk of tuber survival is considered low (indicated by a green marker pin).
- If tubers were exposed to temperatures below 27°F for less than 120 h at 4" depth and greater than 120 h at 2" depth then there was a moderate risk of tuber survival (indicated by a yellow marker pin).
- If tubers were exposed to temperatures below 27°F for less than 120 h at 4" depth and less than 120 h at 2" depth then there was a high risk of tuber survival (indicated by an orange marker pin).

The data for this model are collected automatically from automated weather stations. In Michigan the data are collected from the Michigan Automated Weather Network (MAWN; http://www.agweather.geo.msu.edu/mawn/mawn.html). In Idaho the data are collected from the Agrimet weather network (http://www.usbr.gov/pn/agrimet/index.html). After the model is run, data are posted on a Google map with colored markers indicating the locations of the weather stations (Fig. 1). When users click on the markers they will be given further data on soil temperatures for that station.

Figure 1. Volunteer survival map showing AgriMet weather stations used to collect soil temperature data for the volunteer survival model. The marker color indicates the risk of volunteer survival (orange = high risk; yellow = moderate; green = low).



This winter in Idaho most areas in the Snake River Valley experienced conditions that placed them in the high-risk category for volunteer survival. Even with the severe sub-zero air temperatures we had in mid-November, none of the locations where the model was run this winter (2014/2015) had average monthly soil temperatures below 30°F (Table 1). This situation should alert growers to the high risk of potato volunteers surviving the winter and all growers should therefore be implementing their IPM scouting programs early in 2014 and considering volunteer elimination programs in adjacent non-potato crops if possible. Growers in Southeast Idaho counties (Bingham, Bonneville, Madison, Power Co.) where the 2014 late blight outbreak was most severe should be especially vigilant.

Table 1. Average monthly soil temperatures (°F) at 4 inches below the soil surface for winter 2014/2015.

Month	Agrimet Location								
	Ashton	Rexburg	Aberdeen	Malta	Rupert	Twin Falls	Picabo	Fairfield	Parma
November	37	38	40	37	40	41	37	38	39
December	34	34	39	37	37	39	35	34	35
January	33	31	34	33	32	35	33	32	30
February	33	35	40	39	40	39	34	34	36
March	32	34	38	36	39	38	35	37	35

Cull Potatoes

Late blight can also survive the winter in cull potatoes. Cull potatoes are those potatoes unusable for the fresh market, processing, or dehydration because they don't meet minimum size, grade, or quality standards, or potatoes disposed of for some other reason such as overproduction or waste (slivers) from seed production.

It is difficult to estimate the probability that late blight infected potato stems or foliage will emerge from culled potato tubers. Several factors can influence the fate of the infected tuber. If the infection is severe, then the tuber may rot and prevent sprout development. The tuber infection however may be localized and optimal in terms of inoculum load and therefore it is possible that a developing sprout or the tuber itself could become infected and initiate an epidemic. Under optimal environmental conditions (cool, wet weather) the disease can then spread within individual plants, between plants and neighboring crops. Research has shown that the temperature within discarded cull piles may influence core tuber tissue temperatures affecting the survival of tuber tissue and thus *P. infestans* mycelia in infected tubers. Consequently, the risk of initiation of an epidemic of late blight from cull piles is closely related to the temperature experience of overwintered potato culls. Although the potatoes at the top and bottom of a cull pile may freeze over the winter when ambient air temperatures fall below freezing, research has shown that the temperature in the middle of the pile remained stable regardless of cull pile size (1-15 ton). Since cull piles in excess of 1 ton may enhance the survival of tubers and thus the P. *infestans* mycelia even in the coldest winters it is important to follow cull and waste potato management guidelines.

Cull and Waste Potato Management Options

Potato production and processing operations may accumulate cull piles at any time during the year, but several periods are especially critical. In the spring during cutting and planting, potato waste material may accumulate as seed pieces or tubers are discarded due to size or disease problems. At harvest, potatoes that do not make the grade due to size, disease, or defects are sorted out and discarded prior to placement of the crop in storage. Disposal of cull potatoes discarded from storage or from in-coming seed lots during the spring pose a challenge for the industry. Depending on the timing of disposal, there is a real chance that these culls will not be thoroughly frozen to prevent new growth. Therefore, potatoes which are discarded during the winter and spring as culls should be disposed of in a way that will ensure they do not sprout and grow to provide unprotected foliage which could be a source of late blight to threaten the new season’s crop. The method of disposal will generally depend on the individual situation (location, amount of potatoes, etc.) as well as the time of year. Disposal of potatoes in the winter months when waste potatoes can be reliably expected to freeze can greatly simplify the process, while disposal in the warmer months can greatly add to the challenge of proper disposal.

Disposal of cull potatoes during the winter by spreading them on fields that will not be used for potato production is a very good option for cull potato management. However, it is important to avoid fields that will be planted with potatoes in the following season as cull potatoes can introduce nematodes, weed seeds and other soilborne diseases to the field. Once applied to the field every effort to crush, cut and destroy the tubers should be attempted. These methods include running heavy machinery over the tubers or a cutting tool that does not bury the tubers. Crushing and chopping cull potatoes into smaller pieces makes the tuber tissue more susceptible to rot and desiccation, which is desirable. Weather conditions during the winter will also lead to desiccation of tubers, which will make spring field tillage easier. Avoid tilling until cull potatoes have had substantial time to freeze and desiccate. Premature tilling could bury live tubers deep enough in the soil to insulate them from further exposure to killing temperatures allowing them to survive the winter as volunteer potatoes.

It is extremely important not to pile waste potatoes too high during field disposal. As described above, this practice will often serve merely to insulate the potatoes underneath from freezing. Spread cull potatoes on top of the soil surface no more than two potato layers deep (approximately 6 inches). If spreading tubers is not an option and the amount is small e.g. up to 1000 cwt, growers may opt to dispose of tubers by piling them into **temporary** cull piles. Culls should be piled close to areas where they can be closely monitored to insure that there will be no unprotected sprouting and foliar growth. These culls should be covered with black plastic sheets to increase the temperature of the respiring tubers and accelerate the rate of breakdown.

Whenever cull potatoes are discarded the area should be periodically monitored to assure that any unprotected foliage does not occur. The pile should also not be near residential areas, surface waters or wetlands due to potential for odor and leaching problems.

Cull potatoes are a significant fertilizer source that needs to be accounted for when calculating the fertility requirements of the crop following cull potato application. Fields that will be planted with grain or forage are particularly good candidates for using cull potatoes as a partial fertilizer source.

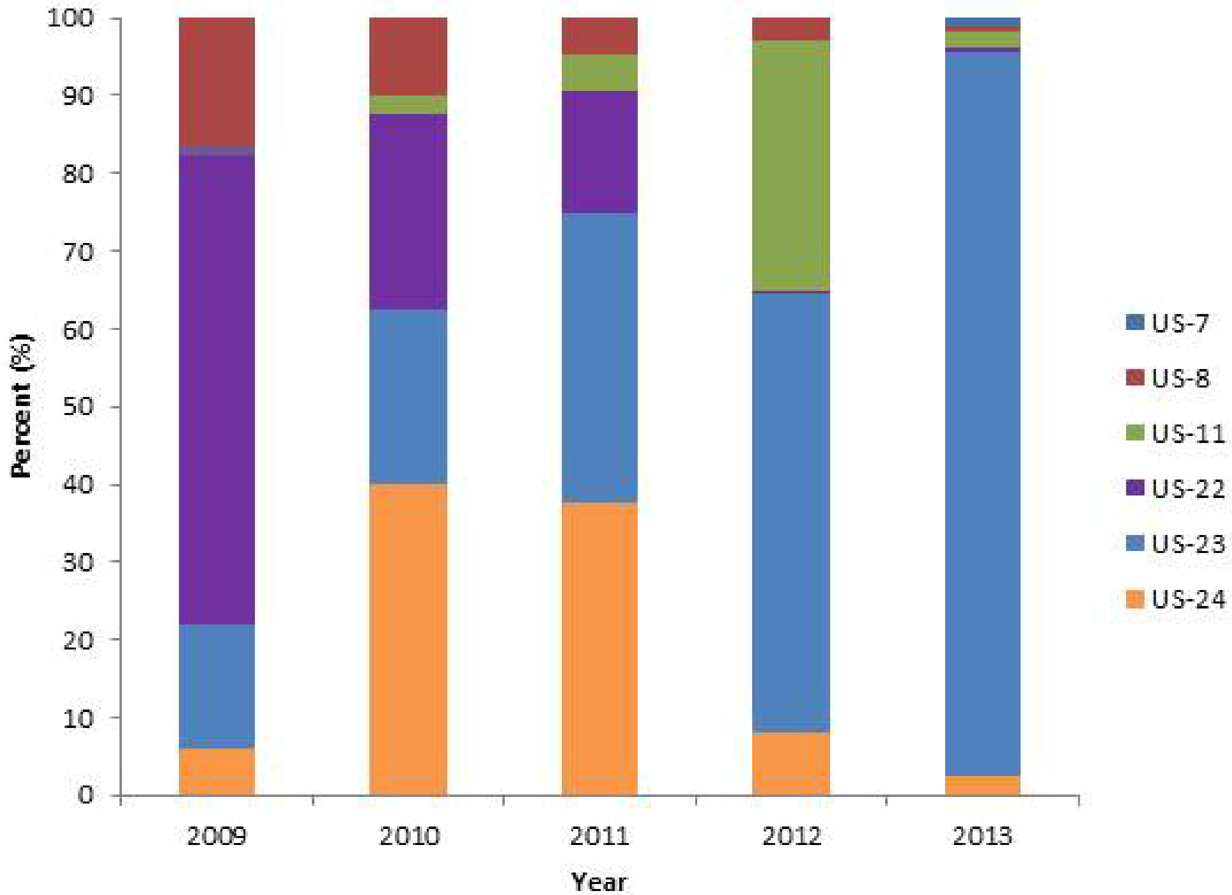
Other options for cull potato management in the warmer months of the year include burial, composting, and livestock feed. For further information refer to the University of Idaho bulletin CIS 814, *Cull and Waste Potato Management*.

Other sources of late blight inoculum

The dry, desert-like climate of Idaho is not conducive to development of late blight epidemics. The pathogen needs cool, wet conditions to sporulate and spread to surrounding healthy plants. This has meant that in a typical year where summer temperatures reach the high 90's °F, and rainfall amounts are less than 1 inch, late blight outbreaks are rare. Any late blight outbreaks that have occurred were likely to be late in the season and limited to a few fields which may have had a micro-climate favoring disease development, such as shading or over-irrigation. These fields may also have been planted with late blight infected seed, which is one of the primary ways that this disease can be moved into areas without a history of infection.

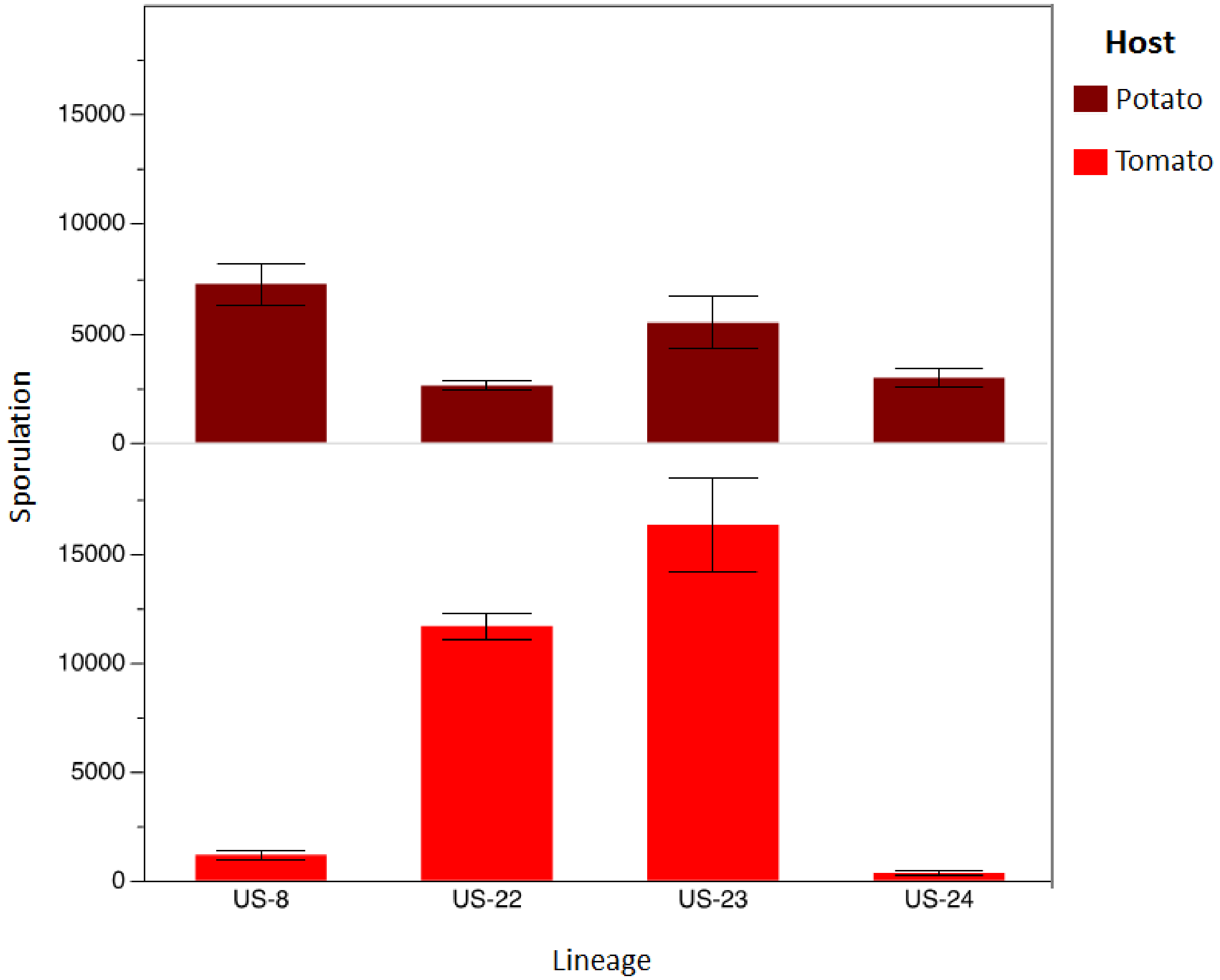
Until 2009, the predominant strain of *P. infestans* found in Idaho was the genotype US 8. In most of the rest of the U.S., this strain has been superseded by a new genotype US 23 (Fig. 2). In 2013, there was a small outbreak of late blight in southeast Idaho. Isolates from that outbreak were genotyped and determined to be US 23. In August 2014, the cool wet weather with daily rain showers and temperatures in the 50s – 70s °F were perfect for a disease epidemic to occur. The first occurrence of late blight was reported on August 12th and this was followed by further outbreaks. Testing of isolates from infected fields showed that they were all of the genotype US 23.

Figure 2. Displacement of *Phytophthora infestans* clonal lineages over time. (From USAblight.org)



Research has shown that these newer genotypes of P. *infestans* are equally pathogenic on tomato and potato (Fig. 3). Epidemiological studies carried out in the Northeastern U.S. and Midwest have shown that recent epidemics of late blight have started on tomatoes growing in home gardens and spread to surrounding potato fields. These infected tomato plants tend to be bought from big box stores and taken home to be planted in the garden. As most of these tomato transplants are produced by the same companies and then shipped all over the U.S. there is the potential for this to be a new source of inoculum for an outbreak of late blight in Idaho if the conditions are conducive for disease development.

Figure 3. Pathogenicity of recent *Phytophthora infestans* genotypes on potato and tomato. From Fry et al., APSnet Features 2012 (http://bit.ly/1ELtEzJ)



Summary of the best late blight prevention options for spring 2015

With the chances of volunteer and cull potato survival over the winter of 2014/2015 being high, growers should adopt the following practices to minimize the risks of a late blight outbreak this spring.

- Only plant certified seed and on receipt, check certification documents.
- Do not store seed near potential sources of inoculum (e.g. cull piles).
- Keep seed lots as separate as possible.
- Minimize cull piles during seed cutting and treating.
- Use a seed treatment with mancozeb, or if using a liquid seed treatment apply a mancozeb dust treatment after the liquid.
- Start scouting for volunteer potato emergence early in the season and around the time of emergence in potato fields planted in your area.
- If potato fields are bordering home owners gardens where tomatoes are being grown and conditions are conducive for late blight (i.e. cool wet weather) be vigilant and scout the borders of the field for late blight symptoms.

For more information on seed piece health management visit
www.idahopotatodiseases.org/seedpiecehealth.html