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Potato Field Day

at OSU-HAREC

June 21, 2017

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HAREC Potato Field Day
June 21, 2017

7:45 – 8:15 am	**Registration with Coffee and Donuts**
8:15 – 8:30 am	**Introductions, Meet and Greet - Director, Phil Hamm, OSU**
8:30 – 8:50 am	**Update on Oregon Potato Breeding and Variety Development – Sagar Sathuvalli, OSU**
8:50 – 9:05 am	**Columbia Root-knot Nematode Resistance Research at OSU – Sapinder Bali, OSU**
9:05– 9:20 am	**Identification of Genetic Resistance to Columbia Root Knot Nematode and Verticillium Wilt in Potato for Soil Health – Ryan Graebner, OSU**
9:20 – 9:40 am	**Nematode Management Update: What to Do for the Rest of 2017 and Preparing for 2018 – Russ Ingham, OSU, and Brian Charlton, Klamath Basin Research and Extension Center**
9:40 – 10:10 am	**Nutrient Requirement for Potato Varieties in the Columbia Basin of Oregon – Ray Qin, OSU**
10:10 – 10:25am	**Lygus in Potatoes: Identification, Biology and Management – Josephine Antwi and Silvia Rondon, OSU**
10:25 – 10:50 am	**Chemical Control of Lygus – Ira Thompson and Silvia Rondon, OSU**
10:50 – 11:05 am	**New Pivot Tracks for Optimum Crop Management – Tim Weinke, OSU and Greg Cook, Circle C Equipment**
11:05 –11:25 am	**Rhizoctonia and Pythium Control Strategies – Joshua Adkins, Syngenta**
11:25 – 11:50 am	**Preview of Plant Pathology Trial Work and Updates on Potato Disease Issues – Ken Frost, OSU**
11:50 – 12:05 pm	**Impact of Potato Virus Y on Tuber Symptoms, Quality in Storage, and Fry Color – Markus Andros, Nora Olsen, Alex Karasev, Cassandra Funke, UI and Ken Frost, OSU**

Thank you Sponsors!

Pesticide credits available: Oregon, 2; Washington, 2; and CCA 4

Potato Variety Management Institute

Echo Russet AO96141-3

Long, medium to late russet, suitable for fresh and processing

- **Cold sweetening resistance**
- **Resistant to *Fusarium* dry rot**
- **High specific gravity**
- **Moderate Dormancy**
- **High US 1 tuber yield**
- **A89222-3 x COA90064-6**
- **Moderately resistant to PVY & PLRV**
- ***Erwinia* soft rot resistant**
- **Resistant to PMTV**
- **Good culinary quality**
- **Medium to high fertility requirements**

Disease Ratings

Early dying	mod resistant
Common Scab	mod resistant
PVY	tolerant
PLRV	resistant
Net Necrosis	mod resistant
Late Blight Foliar	mod resistant
Late Blight Tuber	mod resistant

Weakness: Hollow Heart

Summary of three years data grown in Western Regional trials in Oregon, Washington, Idaho, Colorado, and California, 2006-08.

	Total	US #1			FRY[2]	Merit Score	
Clone	CWT/A	CWT/A	%	SG[1]	45	Fresh[3]	Proc[4]
AO96141-3	584	458	79	1.0922	0.5	3.1	3.9
RANGER R.	553	432	77	1.0908	1.2	2.9	3.5
R. NORKOTAH	457	379	82	1.0739	1.5	3.4	2.5
R. BURBANK	570	355	62	1.0821	1.2	1.9	2.5
Mean	541	406	75	1.0847	1.1	2.8	3.1

[1]Specific gravity was determined using the weight-in-air, weight-in-water method

[2] French Fry Color: 0.0 lighter- 4.0 Darker

[3]Rating: boiling, baking and microwave test. Higher score = better quality; maximum = 25 per test

[4]Fresh market rating: 1 = worst, 5 = best

The information contained within this flyer was supplied by researchers of the Northwest Potato Variety Development Program and their collaborators.

www.pvmi.org

Potato Variety Management Institute

Castle Russet POR06V12-3

Long, medium to late russet, suitable for fresh and processing

- **Cold sweetening resistance**
- **Resistant to *Fusarium* dry rot**
- **Resistant to Corky Ring Spot**
- **High dry matter**
- **High US 1 tuber yield**
- **Moderate Dormancy**
- **Resistant to PVY**
- ***Erwinia* soft rot resistant**
- **Resistant to PMTV**
- **Good culinary quality**
- **Medium fertility requirements**
- **PA00V6-4 x PA01N22-1**

Disease Ratings

Early dying	**mod resistant**
Common Scab	**mod resistant**
PVY	**resistant**
PLRV	**susceptible**
Net Necrosis	**susceptible**
Late Blight Foliar	**susceptible**
Late Blight Tuber	**susceptible**

Weakness: Moderate Glycoalkaloid levels and Hollow Heart

Summary of three years data grown in Western Regional trials in Oregon, Washington, Idaho, Colorado, and California, 2013-15.

	Total	US #1			FRY[2]	Merit Score	
Clone	CWT/A	CWT/A	%	SG[1]	45	Fresh[3]	Proc[4]
POR06V12-3	530	443	82	1.0910	0.5	3.2	3.6
RANGER R.	570	440	77	1.0858	1.5	2.4	2.9
R. NORKOTAH	424	355	82	1.0704	1.8	3.0	2.1
R. BURBANK	544	365	67	1.0782	1.7	1.9	2.4
Mean	517	401	77	1.0814	1.4	2.6	2.7

[1]Specific gravity was determined using the weight-in-air, weight-in-water method

[2] French Fry Color: 0.0 lighter- 4.0 Darker

[3]Rating: boiling, baking and microwave test. Higher score = better quality; maximum = 25 per test

[4]Fresh market rating: 1 = worst, 5 = best

The information contained within this flyer was supplied by researchers of the Northwest Potato Variety Development Program and their collaborators.

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<u>Columbia Root-knot Nematode Resistance Research at OSU</u>

Differential Gene Expresssion Analysis to elucidate the CRKN resistance from *Solanum bulbocastanum*

Sapinder Bali and Vidyasagar Sathuvalli

Hermiston Agricultural Research & Extension Center, Oregon State University, Hermiston, Oregon 97838

Columbia Root Knot Nematode (CRKN) is one of the severe pests of potato in the Columbia basin of the Pacific Northwest. CRKN invades roots and growing tubers, affecting both tuber yield and quality.

(a) (b)

Figure 1: Potato tubers showing (a) external and (b) internal defects due to CRKN invasion **(Pictures: (a) www.inspection.gc.ca (b) Sapinder Bali, HAREC, OSU)**

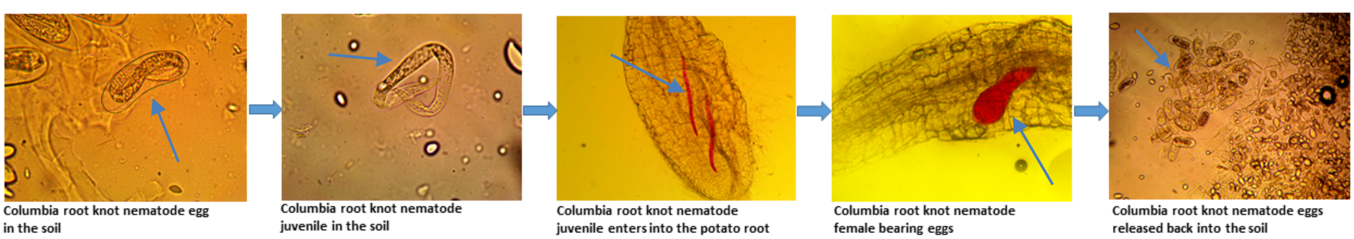


Figure 2: Complete life cycle of CRKN from soil to roots. The cycle completes in 23 days and the nematodes keep multiplying depending upon the availability of the compatible host **(Pictures: Sapinder Bali, HAREC, OSU)**

Solanum bulbocastanum accession SB22, a wild relative of potato from Mexico, has been shown to harbor resistance to CRKN. This resistance was introgressed into tetraploid potato breeding clone, PA99N82-4 and has been mapped onto the upper arm of Chromosome 11.

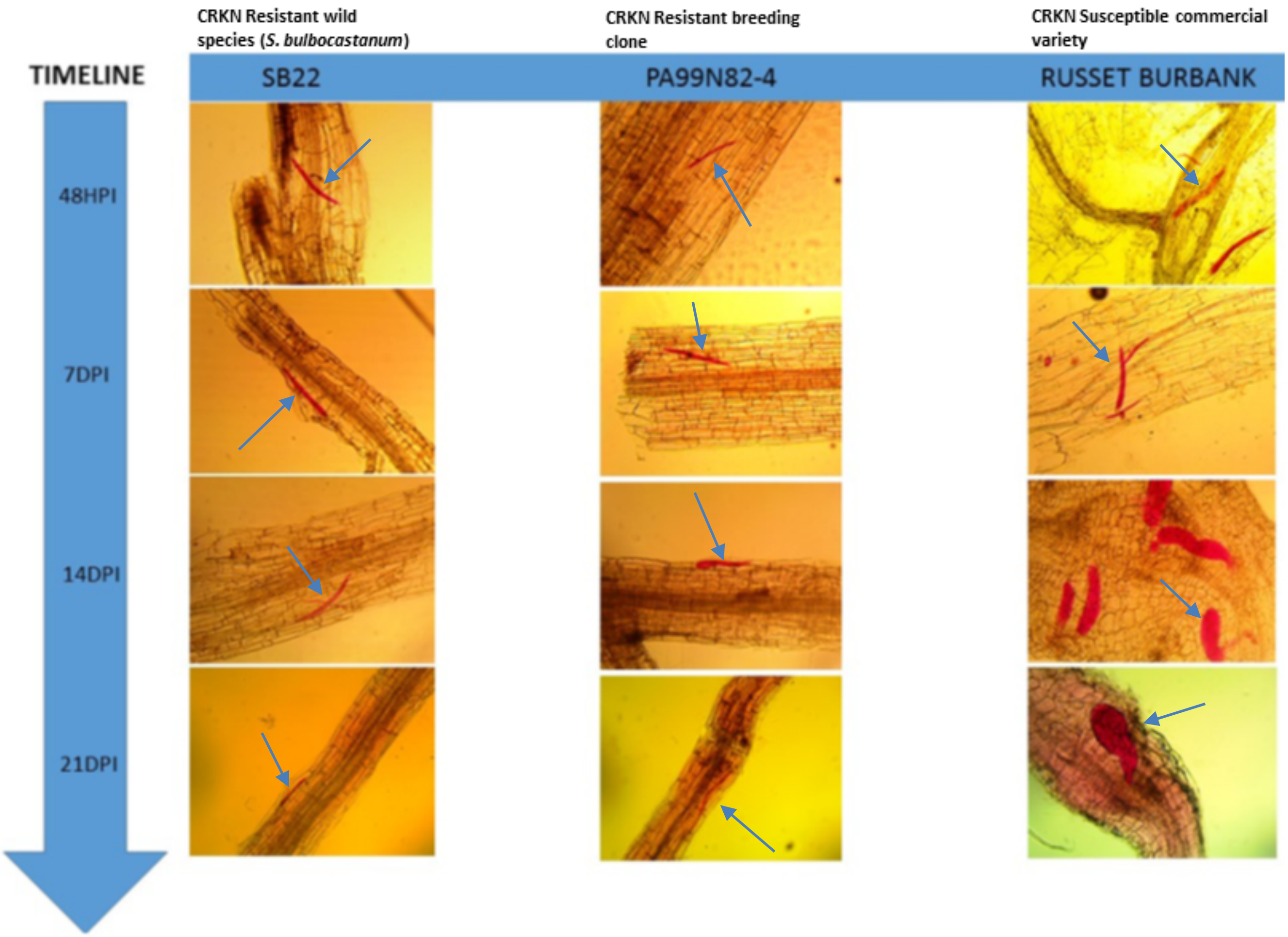


Figure 3: Microscopic examination of the progression of CRKN infection- Resistant versus Susceptible potato clones **(Pictures: Sapinder Bali, HAREC, OSU)**

In order to clearly understand the CRKN resistance mechanism and to facilitate the breeding program to develop commercially acceptable potato varieties with resistance to CRKN, we are using RNA-seq (Gene expression) data to identify the gene(s) that confer resistance from *S. bulbocastanum*. We have sequenced three replicates of the CRKN inoculated root tissue at four time points (Figure 3) from SB22 (Wild species, CRKN Resistant), PA99N82-4 (Breeding clone, CRKN Resistant) and Russet Burbank (Commercial variety, CRKN Susceptible) using Illumina Hiseq 3000 sequencer.

The initial analyses of the sequence shows that on an average 40% of the sequences are successfully mapped to the reference potato genome. Currently, we are looking at the differential analysis of the gene expression between resistant and susceptible clones which will help us to identify the differentially expressed genes during CRKN infection.

Identification of Genetic Resistance to Columbia Root Knot Nematode and Verticillium Wilt in potato for Soil Health

Ryan Graebner OSU, Vidyasagar Sathuvalli OSU

An array of soil-borne pathogens, including nematodes, fungi, and bacteria, can cause devastating losses in potato production if not adequately controlled. As a result, potato fields are heavily treated with different chemical control agents, including fumigants, pesticides, fungicides, and nematicides. However, these chemical control agents are subject to unreliable supply chains, health and environmental concerns and increasing use restrictions. They can cost up to $300-$500 per acre- more than 7% of the expected revenue per acre in the Columbia basin.

One strategy is to shift from the current regime of intensive chemical control to a system that emphasizes soil health. However, for this approach to be successful, it is essential to identify germplasm with moderate to strong genetic resistance to these pathogens, and to successfully incorporate these resistance in to modern day cultivars.

In our research, we are working towards identifying genetic resistance in wild potato germplasm that could be used in the breeding to provide robust genetic resistance against the Columbia root-knot nematode (CRKN), a nematode that establishes feeding sites on potato roots and tubers, and *Verticillium dahliae*, a soil-borne fungi that invades potato vascular bundles, which disrupts water transport, and can lead to the early death of the plant (Verticillium wilt; VW). Both of these pathogens have a wide host range and a long persistence in the soil, hampering the ability of crop rotations to control these pathogens.

To identify new sources of resistance, we inoculated seedlings from nine wild potato species with CRKN and VW. Of those, we identified 18 clones from 3 species with potential resistance to CRKN, and two clones from 2 species with possible resistance to VW. Resistance to CRKN appeared to be largely qualitative in nature, with many of the clones evaluated showing virtually no nematode reproduction. On the other hand, we were only able to find partial resistance to VW, with the most resistant wild potato species be roughly on par with Ranger Russet.

We plan to introgress these new sources of resistance to CRKN and VW in to the elite potato clones. Due to the tendency of plant pathogens to overcome single resistance genes, multiple resistance genes, each with a separate mode of action, should be identified and used to develop improved cultivars to ensure that resistance is not broken down. Developing pathogen-resistant cultivars will help in reduce chemical inputs, decrease or eliminate crop damage from these pathogens, increase grower profitability, and possibly allow the industry to target soil he alth as a management goal.

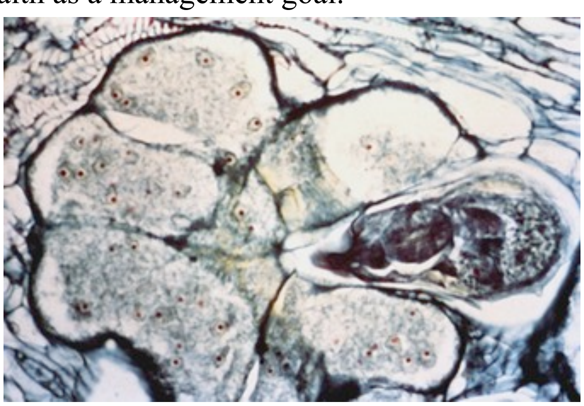


Figure 1. Columbia root-knot nematode (right) and swollen potato cells of feeding site

Figure 2. Wilting caused by Verticillium wilt

Nematode Management Update:
What to do for the Rest of 2017 and Preparing for 2018
Russ Ingham and Brian Charlton OSU

What can be done during the rest of 2017

Using a Velum Prime + Movento program

Chemigate Velum Prime (6.85 oz/a) in 0.50-0.75 in water at rosette stage and 30 days later.

Full rate of 0.5-0.75 in water is needed to push product deep enough into the soil.

Applying in a fast lap and then following with a slow lap of irrigation, as often done with Vydate will not be as effective.

14 and 28 days later apply Movento (5 oz/acre) + 0.5% MSO in 15 gpa water by ground.

Vydate may be available later in the season although the amount is unknown at this time.
Start a chemigation program = 2.1 pts/acre in 0.5 in. water every two weeks until last irrigation.

Preparing for 2018

Telone Supply Update: Fall allocations have been rolled out to the distributors for the fall of 2017. Quantities look similar to fall 2016, but delivery timings may play a factor in overall usable volume for this fall. More product will be arriving in Nov/Dec than in previous years which may increase the availability for spring applications although the total volume that will be available in the spring is not known at this time. Therefore, Telone availability for the 2018 crop is likely to be less than demand again. Growers may want to take advantage of the 2(ee) that recommends rates as low as 11 gpa for nematode suppression to extend available supply. As Vydate reenters the market, following a reduced rate of Telone with a standard Vydate program should provide an excellent option.

Confirm the amount of Telone and Vydate that will be available to you and plan alternatives for shortages.

See June 9, 2017 issue of Potato Progress (XVII, Number 7) for review of topic.

A summary of suggestions include:

1) Use a reduced rate of Telone with full rate of metam sodium or Mocap
2) Make sure conditions are optimal for Telone
   considering shank spacing, temperature, moisture, seal
3) Shank in metam sodium at full rate
   with Mocap broadcast ppi or, preferably, as a tank mix
4) Manage nematodes with rotation crops and green manure crops
5) Manage potato crop to minimize damage should infection occur
   This is more relevant for root-knot than for corky ringspot.
   Once tubers are infected with Tobacco rattle virus there is little that can be done
6) Sample so you know what population levels you have and don't plant potatoes into fields with high population densities.

Effect of New Products on Tuber Damage from Corky Ringspot at KBREC 2016

Application Details

Telone at 12 or 15 gpa shanked in at 18 in April 30

Dominus (allyl isothiocyanate) Isagro USA, 10 gpa + 30 or 70 gpa water shank injected May 6

MeloCon (*Paecilomyces lilacinus* = fungal parasite of nematodes) Certis 6 lb/a infurrow May 22

Majestene (heat killed *Burkholderia*; bacteria w/nematode toxin) Marrone Bioinnovations
1 gpa in-furrow, 1 gpa on June 20 and July 18 applied with backpack sprayer between 0.25 in. and 0.75 in. irrigation sets

EM-UNE (Potassium phosphate and Natural Fermentation Products) AGSCI Tech
1 gpa in-furrow, 1 gpa on June 20 and July 18 then 0.66 gpa on Aug 4 and Aug 18 applied with backpack sprayer between 0.25 in. and 0.75 in. irrigation sets

Results

Treatment	**% Tubers with > 5% Damage**
Untreated	45 a
Telone 12 gpa	3 bc
Telone 15 gpa	1 c
Dominus 10 gpa plus 30 gpa water	11 bc
Dominus 10 gpa plus 70 gpa water	22 abc
MeloCon 6 lb/acre in-furrow	30 ab
Majestene	30 ab
EM-UNE	30 ab

- Only Telone provided acceptable levels of damage.
- Both Dominus treatments were not different than Telone – 10 gpa probably too low a rate
- MeloCon in-furrow alone is insufficient for season long control but post plant apps not allowed
- Applying Majestene and EM-UNE between irrigation sets may not simulate chemigation

2017 Research trials

As time goes on using combinations of products rather than relying on a single nematicides will likely become more common. Several combinations are being tested at HAREC by me or Craig Collins of Collins Agricultural Consultants in cooperation with various companies.

Salibro (a new and unregistered nematicide from DuPont) and Vydate: Several years of testing have demonstrated the Salibro is equal to Vydate when used as a replacement for the in-furrow application of Vydate in the standard program. Since Salibro is much less toxic than Vydate this combination should be welcomed by growers who dislike applying Vydate at planting. This year we will be testing if Salibro can replace in-season Vydate applications.

Velum Prime - Movento – Vydate: Velum Prime applied in-furrow has been as effective as Vydate when used in-furrow. Unfortunately Bayer does not want growers in the PNW to use Velum Prime in-furrow until they have established MRLs for export which may not be until the 2019 growing season. This year we will be testing several combinations of Velum Prime, Movento and Vydate to determine if they are as effective as Velum Prime applied in-furrow.

Nitrogen requirement for new potato varieties for the Southern Columbia Basin of Oregon and Washington

Ruijun Qin, Vidyasagar Sathuvalli, and Dan M. Sullivan

Introduction:

Over recent years, new potato varieties are released by the Tri-state potato variety development program. However, the nutrient management plan for these varieties is still based on growers' standard for the traditional varieties (Ranger Russet and Russet Burbank). There is a need to study the nutrient requirement for the new varieties and correspondingly update the nutrient management plan in order to achieve the sustainable crop production while effectively improving nitrogen use efficacy.

The objectives of our studies are to quantify the nitrogen for the new varieties through greenhouse experiments and field trials. These research findings will be important for growers in the region towards economical and sustainable crop production.

Soil information:

The field trial will be conducted from May to October, 2017 at OSU-HAREC field with a soil type of Adkins fine sandy loam with chemical properties refereed in Table 1.

Table 1: Soil information

	pH	OM (%)	NO_3^- (lbs/ac)	NH_4^+ (lbs/ac)	P_2O_5 (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	S (ppm)	Zn (ppm)	B (ppm)
Soil	6.4	0.6	7	9	16	182	114	23	3.4	1.2	0.2

Potato varieties:

Two traditional varieties (Russet Burbank and Ranger Russet) and two to be released new varieties [(Castle Russet (POR06V12-3) and Echo Russet (AO96141-3)] are included in the study.

Russet Burbank is a potato cultivar with dark brown skin and few eyes that is the most widely grown potato in North America. Its flesh is white, dry, and mealy, and it is good for baking, mashing, and French fries.

Ranger Russet is a full season variety which produces high yields of high quality, long, russet-skinned tubers which are slightly flattened. It is well suited for frozen processing and fresh market.

Castle Russet (POR06V12-3) is a long, medium to late russet suitable for the fresh and processing markets with an exceptional disease resistance package including PVY, mop top, corky ring spot and Fusarium resistance. It has been highly rated for culinary quality.

Echo Russet (AO96141-3) is a high yielding, long, medium to late russet with cold sweetening resistance and excellent processing qualities. It has resistance to Fusarium and *Erwinia* and good culinary qualities.

Nitrogen fertilizer rate:

Four levels of N (140, 250, 375, 500 lbs/acre) are being tested in field, while the other fertilizer follows to the conventional application rate. The field fertilizers are divided as base fertilizer, starter fertilizer, and on-season top dressing. The base-fertilizer and starter fertilizer are same for all the plots (Table 2).

Table 2: Base fertilizer and starter fertilizer (lbs/ac)

Fertilizer	N	P_2O_5	K	Ca	Mg	S	Zn	B
Base	90	0	60	105	0	133	0	3
Starter	50	90	0	0	0	30	2	0

The difference in fertilizer rates will be based on in-season application (Table 3). For the N level of 140 lbs/ac, no additional N will be applied as the total amount of N was sourced from base fertilizer and starter fertilizer. For the higher level of N, the N application will be carried out throughout the season as several applications.

Table 3: Fertilizer rate for each treatment (lbs/ac)

Target rate	140 lbs/ac	250 lbs/ac	375 lbs/ac	500 lbs/ac
Base	90	90	90	90
Starter	50	50	50	50
Top dressing	0	110	235	360

Experimental design:

Randomized complex block with 3 replicates. Each plot has 25 ft long and 10 ft wide with 4 rows. The inner rows are used for field sampling and monitoring and outer rows are used as buffer area. In total, there are 48 plots.

Sampling and field observation:

We plan to collect potato growth data throughout the crop season. Petiole samples and soil samples will be taken bi-weekly for understanding nitrogen dynamics. The impact of nitrogen fertilizer on other nutrients such as P, K, S, and micronutrients will also be monitored. At the end of the season, we will harvest potato tubers and collect yield data and quality data.

Besides soil and plant nutrition data, we will also monitor the impact of the potato varieties and nitrogen fertilization on the occurrences of insects and diseases.

Future studies:

We plan to use transparent plastic boxes with lids to grow micro tubers and pot experiments for studying nutrient uptake mechanisms for the future studies.

Potato Response to New Potassium Fertilizer Compared to MOP and MOP Balanced fertilizers in Oregon

Ruijun Qin

Description:

Potatoes are sensitive to chloride and require large quantities of potassium and calcium and respond to sulfate fertilizers. The project aims to deliver a commercial demonstration, which evaluates new potassium products compared to muriate of potash (MOP) with/without S, Ca, and Mg or in blends of new product with MOP at the current K_2O recommendation rate for Ranger Russet potatoes in Oregon. The field trials are being carried out from May to October. Field observation, sampling, and data collection are on-going. More detailed information will be available after harvest.

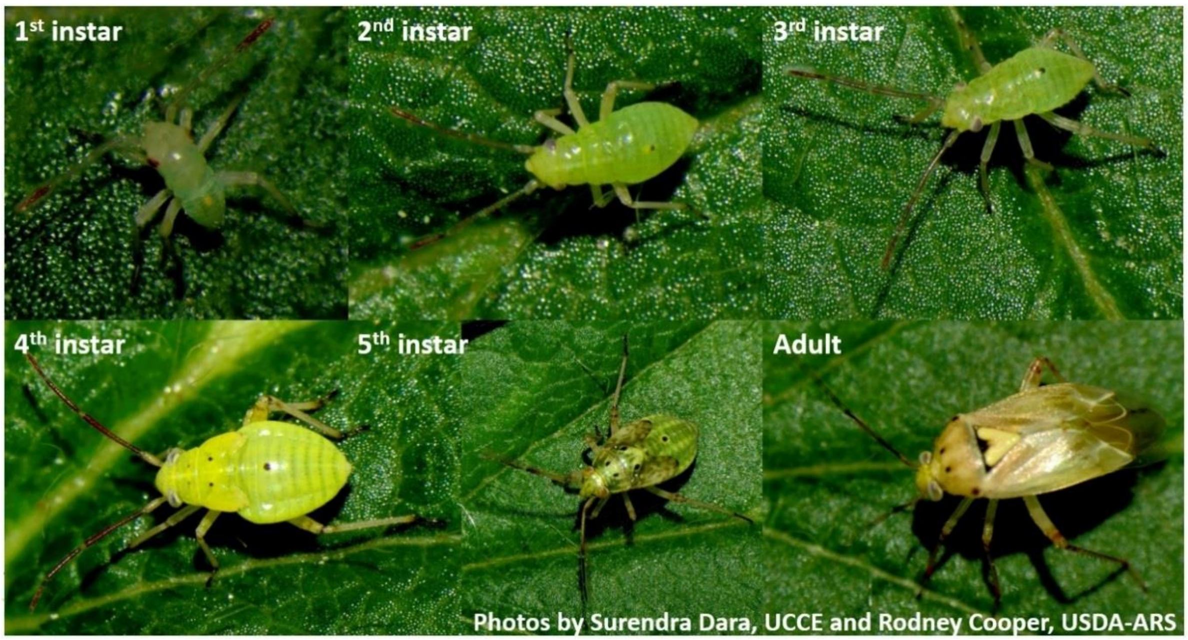
Lygus bugs: Identification, Biology, and Management

Josephine Antwi and Silvia I. Rondon

Irrigated Agricultural Entomology Program (IAEP)

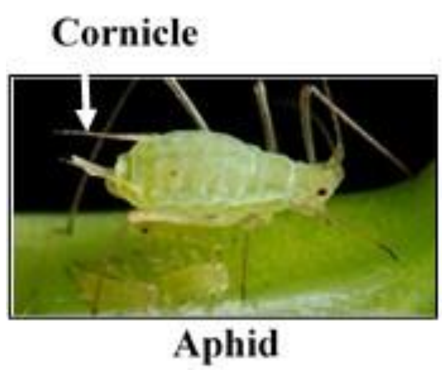
The general aim of the project is to understand the biological and ecological dynamics of *Lygus* bugs on potatoes.

How to identify Lygus bugs: life cycle



Don't confuse immature Lygus bugs with aphids

- Immature *Lygus* bugs move faster than aphids.
- Aphids have tube-like extensions (cornicles) at the end of their abdomen.



Facts about Lygus bugs

What do we know?

- There are more than one species of *Lygus.*
- *Lygus* are widely distributed.
- *Lygus* are associated with potatoes.
- *Lygus* have been found to be associated with purple top disease.

What we do not know …. yet

- Can *Lygus* vector purple top disease?
- How many *Lygus* are too many on potatoes?
- Do *Lygus* affect potato quality?
- Do *Lygus* affect potato yield?
- Are there any varietal differences in the effect of *Lygus*?

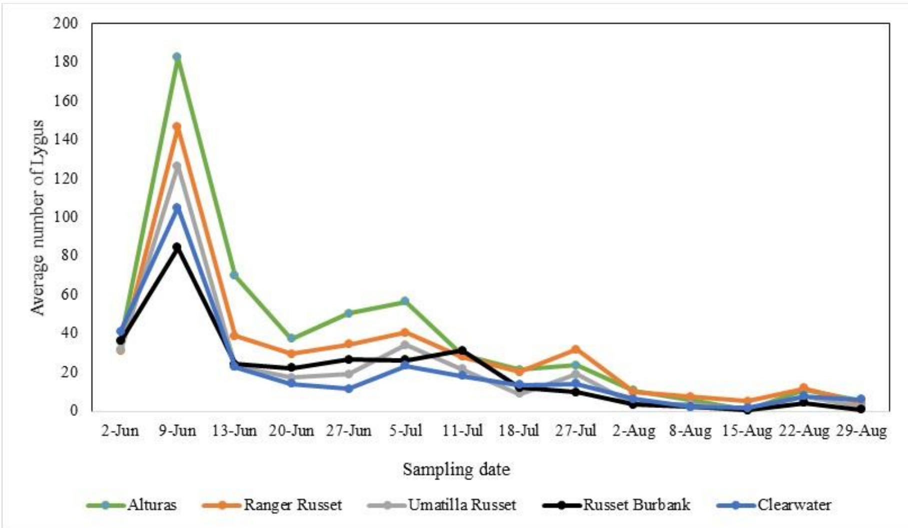
Relative abundance of Lygus on different varieties of potatoes

Methods:

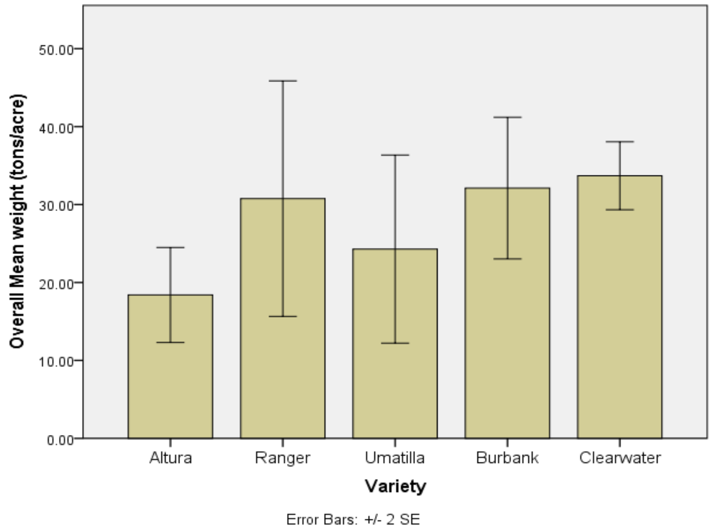
- Five potato varieties: Alturas, Ranger Russet, Umatilla Russet, Russet Burbank, and Clearwater were planted in a Latin Square design with 5 repetitions per variety.
- Alfalfa was planted around potato field to attract *Lygus*.
- *Lygus* were sampled on a weekly basis.
- Yield was estimated.

Results (Year 1)

- *Lygus* counts were higher each time alfalfa was cut.
- Population dynamics of *Lygus* was uniform in each sampling date.
- There were varietal differences in *Lygus* abundance.
- There were numerical differences in yield but no statistical differences.



Weekly abundance of *Lygus* bugs



Mean weight of potatoes in tons/acre

Vertical distribution of Lygus damage within plants

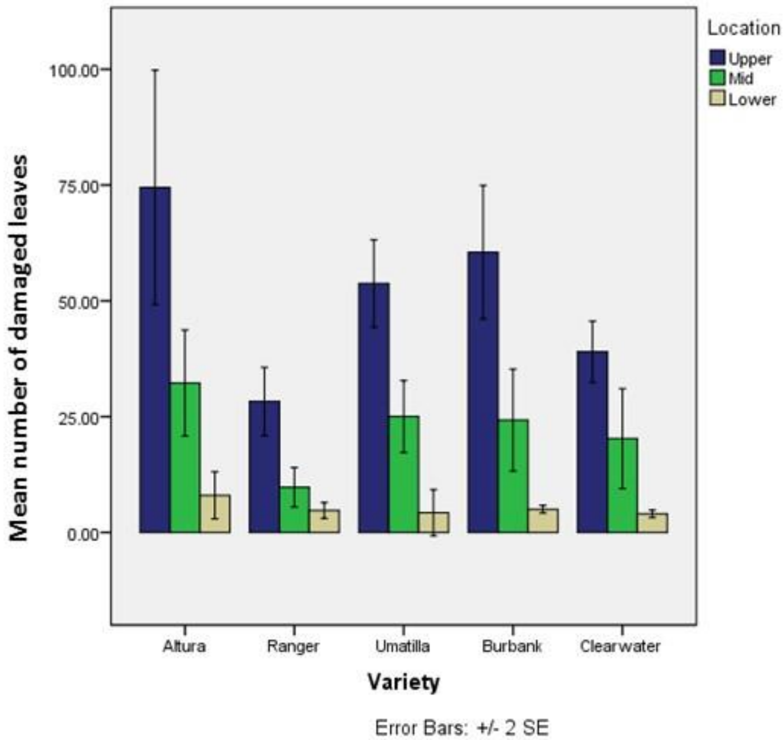
Methods:

- All potato varieties were assessed for damage.
- Canopy level of each potato plant was divided into 3 regions: upper, middle, and low.
- Damage was estimated.

Lygus bugs damage on potatoes include leaf flagging (a), leaf deformation (b) and brown lesions on leaves and stems (c)

Results (year 1)

- Highest number of *Lygus* damage was found in the upper canopy, followed by mid, and low canopy.
- There were varietal differences in *Lygus* damage per canopy level.
- The most damage was recorded on Alturas.
- Ranger Russet was least damaged by *Lygus*.



Mean number of leaves per variety showing *Lygus* damage. Plant foliage were divided into 3 levels: upper, mid and lower.

Can Lygus bugs vector purple top disease?

Ongoing studies

- Through molecular analysis (e.g., PCR), we have detected the causal agent of purple top disease (BLTVA) in *Lygus*. We do not know the location of the pathogen within the body of *Lygus* (e.g. salivary glands, hemolymph?).
- A series of greenhouse experiments were conducted where *Lygus* were allowed to feed on purple top-infected plants and later transferred *Lygus* to healthy plants.
- Healthy plants exposed to *Lygus* developed purple top-like symptoms. Symptoms included swollen nodes, shortened internodes, and witches broom (i.e., bushy foliage). However, a small percentage of plants tested positive for BLTVA. Thus, are we dealing with a new organism? Could these symptoms be due to a different disease?

Future directions

There are still many uncertainties about *Lygus*-purple top interactions. To better understand the nature of this relationship, we will be digging deeper into understanding the fate of the causal agent of purple top when it is in contact with *Lygus* (FISH).

Conclusions and Implications of study

- There are several species of *Lygus* in the region.
- In general, there are high numbers of *Lygus* bugs in potatoes.
- *Lygus* feed and reproduce on potatoes. At least 2 ½ generations per season. Feeding and oviposition damage are characteristic.
- More *Lygus* damage occurs in the upper canopy.
- Potato varieties such as Alturas harbor more *Lygus* than other varieties.
- Alfalfa may play a role in *Lygus* abundance in potato fields.
- Inverted leaf blower better than sticky cards for monitoring *Lygus*.
- *Lygus* bugs have been associated with purple top disease, however, the nature and the efficiency of the transmission is still under investigation.
- *Lygus* damage may be associated with yield reduction.

Arthropod Management Tests, 2017, 1–2
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Section E: Vegetable Crops

POTATO (RUSSET): *Solanum tuberosum* L., ‘Ranger Russet’

Lygus Control in Potato, 2016*

Silvia I. Rondon[1,2] and Daniel I. Thompson[1]

[1]Department of Crop and Soil Science, Hermiston Agricultural Research and Extension Center, Oregon State University, 2121 South First St., Hermiston, OR 97838, Phone: (541) 567-8321, Fax: (541) 567-2240 (silvia.rondon@oregonstate.edu; maxcanyon123@gmail.com), and [2]Corresponding author, e-mail: silvia.rondon@oregonstate.edu

Subject Editor: Mark Abney

Lygus spp.

Potato | *Solanum tuberosum*

Lygus bug | Miridae spp.

The objective of this study was to evaluate the efficacy of registered insecticides for control of lygus bugs in the Columbia Basin. “Ranger Russet” potatoes were planted into single rows on 32-inch centers with 9-inch plant spacing on 20 Apr 2016. Plots were 4 rows wide and 25-ft long (7.6 m) with a 5 ft (1.5 m) buffer between plots. The potato crop was established by withholding water until emergence and then irrigating with 1-inch (2.5 cm) overhead irrigation using a standard center-pivot irrigation system to replicate commercial growing practices in the region. Each treatment was replicated four times, and plots were arranged in an RCB. Foliar treatments were applied using a CO_2 powered boom sprayer with TeeJet AI8002 nozzles at 40 psi, and 30 gpa (280.6 l/h). Dyne-Amic (Helena Chemical Co.) was applied at 0.25% vol/vol to all treatments. Lygus populations were sampled using an inverted 25.4 cc low noise handled leaf blower (Echo 165 MPH 391 CFM). Twelve plants were sampled. On each sampling date, samples were taken from the center rows and placed into a fine mesh bag secured at the end of the device with a thick rubber band. Samples were transferred into a one gallon resealable plastic bag and placed at 8 °F for 48 h to kill insects before sorting. Lygus populations were assessed by estimating the number of lygus per plot by week; lygus adults and immatures were counted separately. Lygus data were log transformed (mean + 1) and were arcsine transformed prior to the ANOVA and *F*-protected LSD ($P \leq 0.05$) to distinguish treatment mean differences.

There was moderate lygus pressure during the trial. As the population began to rise in mid-Jun, the first application was made. A day before the beginning of the trial, prespray estimates for *Lygus* spp. in all plots combined were 15.2 ± 2.3 and 11.2 ± 1.5 lygus adults and nymphs per plant, respectively. There is no preestablished threshold for *Lygus* spp. in the Columbia Basin. In general, Lygus nymph counts increased steadily in the untreated plots. By 8 DAT, some significant differences were observed (Table 1); nymph counts were lower compared with the check in all plot treatments except Sevin XLR; however, all counts increased at 15, 22, 29, and 35 DAT. Nymph counts in the Vydate Cl-V and Permethrin plots were significantly lower compared to the check. Similarly, lygus adult counts increased steadily in the control plots. Adult counts were significantly lower in Permethrin and Asana treatments compared to Sevin XLR. By 35 DAT, all treatments except Sevin XLR showed a significantly lower population of lygus adults compared to the check.

These results suggest a short-term effect of pesticides at reducing either lygus nymphs or adults. Vydate Cl-V and Permethrin kept immatures and adults at lower levels while Beleaf and Asana XL kept only adults at low levels at 35 DAT. No phytotoxicity symptoms were observed following any of the insecticide treatments.

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Table 1

Treatment/formulation	Rate form/acre	Immature *Lygus* spp./plant					
		1 DAT 17-Jun	8 DAT 24-Jun	15 DAT 29-Jun	22 DAT 6-Jul	29 DAT 13-Jul	35 DAT 20-Jul
UTC	–	9.0	4.3 a	35.8 a	32.0 ab	75.8 a	41.0 a
Vydate Cl-V	24 fl oz	0.5	0.3 c	4.0 b	13.3 b	19.5 c	17.0 b
Permethrin-L	8 fl oz	1.5	0.8 bc	10.8 b	16.8 b	32.0 bc	19.3 b
Beleaf-L	2.8 oz	0.8	1 bc	19.5 ab	35.8 ab	43.0 b	34.5 a
Asana XL	9.6 fl oz	1.8	1.3 bc	16.0 b	31.0 ab	46.5 b	29.8 ab
Sevin XLR	32 fl oz	6	2.8 ab	35.3 a	77.5 a	74.3 a	44.0 a
	F value	2.49	7.97	7.18	4.81	15.74	7.381
	Pr>F	0.078	0.0008	0.001	0.0080	0.0001	0.0011

Means in a column followed by the same letter are not significantly different ($P > 0.05$, *F*-protected LSD).

Table 2

Treatment/formulation	Rate/acre	Adult *Lygus* spp./plant					
		1 DAT 17-Jun	8 DAT 24-Jun	15 DAT 29-Jun	22 DAT 6-Jul	29 DAT 13-Jul	35 DAT 20-Jul
UTC	–	14.8 a	1.8	4.5	8.8	23.3 ab	45.5 a
Vydate Cl-V	24 fl oz	4.5 c	2.5	4.3	9.8	18.8 ab	21 c
Permethrin	8 fl oz	4.3 c	2.3	4.3	8.3	13.8 b	22.8 c
Beleaf	2.8 oz	7.8 bc	4.0	5	9.8	15.5 ab	28.5 bc
Asana XL	9.6 fl oz	3.5 c	4.8	3.3	10.5	12.8 b	22.3 c
Sevin XLR	32 fl oz	11.0 ab	2.8	5.5	11.25	26.5 a	42 ab
	F value	12.31	1.87	0.40	0.38	4.198	10.106
	Pr>F	0.0001	0.16	0.84	0.85	0.0138	0.0002

Means in a column followed by the same letter are not significantly different ($P > 0.05$, *F*-protected LSD).

Preview of Plant Pathology Trial Work and Updates on Potato Disease Issues

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Late Blight: Late blight has not been reported in the Columbia Basin.

Weather conditions this spring have been conducive for the occurrence of late blight (88 – 99% likelihood it will occur based on rain events in April and May).

Late blight biology:

- Caused by a fugal-like, oomycete pathogen, *Phytophthora infestans*
- The pathogen overwinters in infected tubers (i.e. seed, cull piles) or as oospores if opposing mating types are present and mate
- Sporangia or zoospores can infect a susceptible plant –rain splash, wind, or mechanically dispersed
- Symptoms generally appear as water-soaked spots on leaves or stems and those spots grow if weather permits. Sporulation appearing as white fuzz often occurs at lesion boarders on undersides of leaves.
- Moderate air temperatures (60 – 80 F) and wet conditions are favorable for late blight. Under these conditions growth and reproduction can be rapid and result in decline potatoes that are not protected.

Common *P. infestans* clonal lineages in the U.S.

Clonal Lineage	Mating Type	Host (s)	Mefenoxam Sensitivity
US-1	A1	potato	sensitive
US-8	A2	potato/tomato	resistant
US-11	A1	potato/tomato	resistant
US-22	A2	potato/tomato	sensitive
US-23	A1	potato/tomato	sensitive
US-24	A1	potato/tomato	resistant

Late blight management (Exclusion):

- Purchase and plant clean certified seed
- Manage volunteers
- Manage irrigation closely
- Scout fields regularly and monitor weather forecasts for rain events

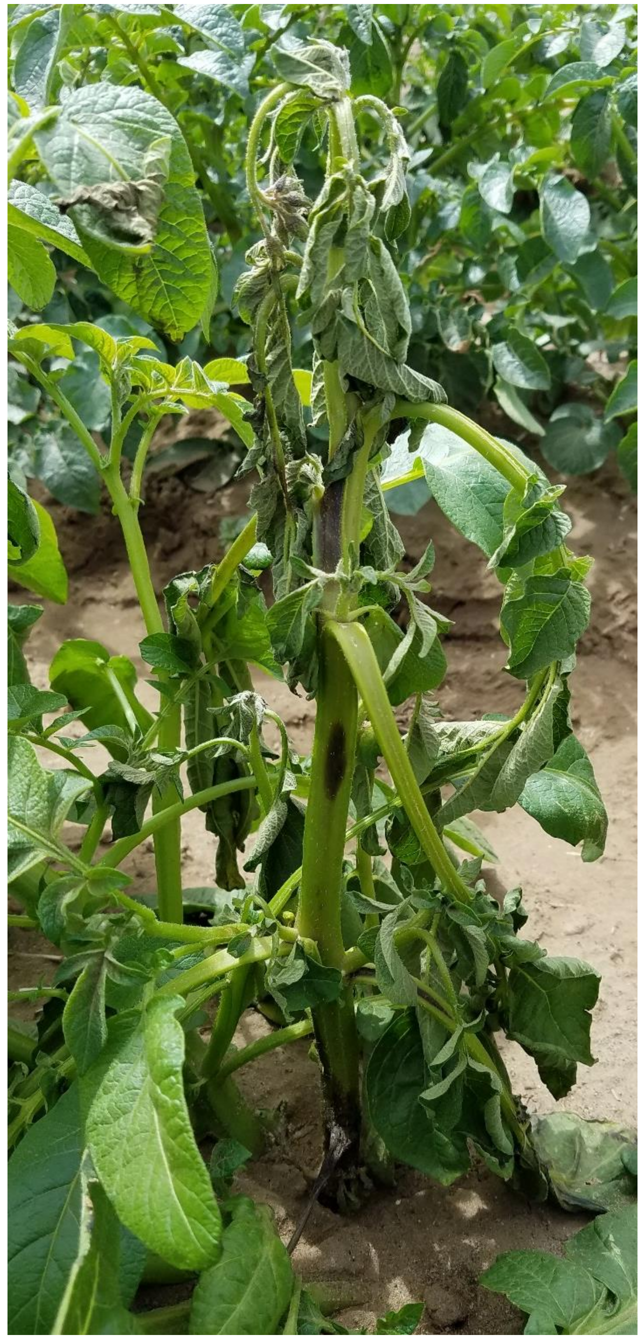
- Use protective fungicide applications to prevent infection by *P. infestans*.

Potato Trial Work 2016 (Come check things out after lunch):

1) Seed Lot Trial, 2) PVY screen house, 3) Impact of PVY on yield and quality, 4) White mold (FMC), 5) Verticillium wilt "dose-response" trial, 6) Pythium leak, 7) Soft rot cut and uncut seed, 8) Verticillium biologicals 9) Black Dot (Syngenta) and 10) PVY sentinel traps.

Soft rot, blackleg, and aerial stem rot:

- Primarily caused by the bacteria *Pectobacterium atrosepticum, P. carotovorum, P. wasabiae*, and **NOW** *Dickeya* spp. Previously these pathogens were grouped in the same genus *Erwinia*
- *Dickeya* and *Pectobacterium* affect many host species including potato, carrot, corn, and parsnip; legumes and small grains are not known to be hosts of these bacteria
- *Dickeya dianthicola* was first reported the northeast U.S. in 2015; later reported in 10 different states.
- By the fall of 2016, *D. dianthicola* was detected in 23 states and two Canadian provinces.



Black leg/soft rot symptoms:

- Cell-wall-degrading enzymes produced by the bacteria result in a variety of disease symptoms
- Environmentally variable but generally promoted by cool, wet conditions at planting and high temperatures after emergence
- Both genera produce similar sometimes indistinguishable symptoms
- Poor emergence, chlorosis, wilting, tuber and stem rot, and darkened or black stems which are slimy, and death
- *Dickeya* spp. (and *P. atrosepticum*) tend(s) to be a problem in warmer temperatures, above 77ºF
- In low humidity infection by *Dickeya* spp. may cause wilting, stem browning, or stem hollowing
- *Pectobacterium* species occur more commonly when temperatures are below 25ºC

Sources:
- Infested seed, soil, irrigation water, and even insects
- Seed can be assayed for *Dickeya* and *Pectobacterium* using polymerase chain reaction (PCR)
- Testing of 400 random tubers per seed lot will, on average, identify seed lots with 1% or greater incidence
- Disease thresholds for *Dickeya* are not yet determined and thresholds for *Pectobacterium* have not been determined recently with newer strains of the pathogen

Management:
- There are no curative chemicals or completely resistant varieties
- Sanitize farm machinery, eliminating plant debris and alternative hosts, and avoidance of mechanical harvesting during the early phases of pre-basic seed tuber multiplication
- Cutting seed will spread *Pectobacterium* and *Dickeya* within a seed lot
  - Consider planting uncut seed when possible
  - Pre-inspect seed before cutting remove rotten
  - Suberize cut seed prior to planting
  - Sanitize seed cutting equipment and planter between seed lots
- Plant seed when it is at the same temperature as the soil to avoid condensation on seed piece
- Avoid causing damage during harvest (soft rot) – small wounds allow pathogen entry
- Avoid portion of the field with known high incidence of soft rot
- Improved storage management can reduce bacterial load on tubers and tuber rotting.

Soft Rot Trial:

Treatment	**Variety**	**Seed**	**Pathogen**	**Key**
1	Burbank	Cut	Mock inoculated	
2	Burbank	Cut	Pcc	**Pcc =** Pectobacterium carotovorum subsp. carotovorum
3	Burbank	Cut	Dch	**Dch =** Dickeya chrysanthemi
4	Burbank	Cut	Pcc + Dch	
5	Burbank	Whole	Mock inoculated	
6	Burbank	Whole	Pcc	Effort was made to plant seed pieces that were of similar sizes for all treatements. For the cut treatment, seed was cut and immediately inoculated with 150 ml of bacterial suspension (1 .0 X 10^8 cells per ml) in a large garbage bag. The whole seed treatment was not cut, but inoculated the same as the cut seed treatments. Mock inoculated treatments were inoculated with 150 ml or sterile distilled water. Each treatement was applied to 50 lbs of seed and seed pieces were allowed to incubate at ambient temperature for 16 hours prior to planting.
7	Burbank	Whole	Dch	
8	Burbank	Whole	Pcc + Dch	
9	Umatilla	Cut	Mock inoculated	
10	Umatilla	Cut	Pcc	
11	Umatilla	Cut	Dch	
12	Umatilla	Cut	Pcc + Dch	
13	Umatilla	Whole	Mock inoculated	
14	Umatilla	Whole	Pcc	
15	Umatilla	Whole	Dch	
16	Umatilla	Whole	Pcc + Dch	

Assessments: Emergence, wilting and blackleg, soft rot at harvest, yield and grade.

Seed lot Information:

Plot	Variety	Plot	Variety	Plot	Variety
1	Shepody	37	Dakota Crisp	73	-
2	Ranger Russet	38	Reds	74	Norkotah
3	Norkotah	39	Columba	75	Burbank
4	Ranger Russet	40	Russet Burbank	76	Burbank
5	Norkotah	41	Norkotah	77	Umatilla
6	Shepody	42	Dakota Pearl	78	Clearwater
7	Ranger Russet	43	Russet	79	Shepody
8	Dakota Pearl	44	-	80	Umatilla
9	Dakota Pearl	45	-	81	Burbank
10	Norkotah	46	Shepody	82	Alturas
11	Norkotah	47	-	83	Alturas
12	Norkotah	48	Burbank	84	Shepody
13	Norkotah	49	Burbank	85	Ranger Russet
14	Alturas	50	Burbank G3	86	Ranger Russet
15	Norkotah	51	Burbank	87	Clearwater
16	Norkotah	52	Juanita		
17	Premier	53	Burbank G3		
18	Ranger Russet	54	Russet 296		
19	Alturas	55	Burbank G3		
20	Clearwater	56	Wantea		
21	Clearwater	57	Burbank		
22	Clearwater	58	Burbank		
23	Shepody	59	Burbank		
24	Clearwater	60	Norkotah		
25	Ranger Russet	61	Reds		
26	Ranger Russet	62	Goldeye		
27	Ranger Russet	63	Burbank		
28	Premier	64	.		
29	Alturas	65	Burbank		
30	Alturas	66	Ranger Russet		
31	Shepody	67	Burbank		
32	Alturas	68	Burbank		
33	Russet Burbank	69	Burbank		
34	Lamoka	70	Ranger Russet		
35	Snowden	71	Norkotah		
36	Lamoka	72	Burbank		

Seed lot plot map:

N

1st St				
	1	3	5	1st Planting
	2	4	5	
	6	8	10	
	7	9	10	
	11	13	15	
	12	14	15	
	16	18	20	
	17	19	20	
	21	23	25	
	22	24	25	
	26	28	30	
	27	29	30	
	31	33	35	
	32	34	35	
	36	38	40	
	37	39	40	
	41	43	45	2nd Planting
	42	44	45	
	46*	48	50	
	47*	49	50	
	51	53	55	
	52	54	55	
	56	58	60	
	57	59	60	
	Dive Row			
	61	63	65	
	62	64	65	
	66	68	70	
	67	69	70	
	71	73	75	
	72	74	75	
	76	78	80	
	77	79	80	
	81	83	85	
	82	84	85	
	86	87	B	
	B	B	B	