**Minutes** **- WERA89**

**March 15th-16th, 2022**

**Potatoes USA, Denver CO**

*Chair: Steve Hystad – Montana Seed Potato Certification*

*Vice Chair: Max Feldman – USDA-ARS*

*Secretary: Julie Pasche – North Dakota State University*

**Tuesday March 15th, 2022**

8:00am Call to Order, Introductions, 2021 Minutes approval, 2022 Agenda discussion/approval

Attendees:

|  |  |
| --- | --- |
| On-line:  David Douches  Hanu Pappu  Jason Ingram  Jonathan Whitworth  Joseph Coombs  Kylie Swisher Grimm  Max Feldman  Melanie Filiatrault  Steve Hystad  Tami Brown  Alan Westra  Prabu Gnanasekaran  Mathuresh Singh  Richard Manasseh  Hira Kamal  Kiwamu Tanaka  Gregory Elison  Brooke Babler  Rich Novy  Noelle Anglin | In-person:  Adam Winchester  Alexander Karasev  Alice Pilgeram  Amy Charkowski  Andrew Houser  Brian Charlton  Erik Wenninger  Jen Rushton  John Mizicko  Julie Pasche  Kasia Duellman  Kenneth Frost  Kent Sather  Lynn Woodell  Mark Pavek  Nathan Gelles  Nina Zidack  Nora Olsen  Rabecka Hendricks  Renee Rioux  Sarah Hensley  Teresa Almeida  Vamsi Nalam  Vidyasagar Sathuvalli  Yuan Zeng |

8:20am Administrative Advisor Report and other business

• The SCRI reporting meeting will be held tomorrow – March 16th – led by Alex Karasev

8:30am State Certification Reports

**Adam Winchester – Potato Certification Association of Nebraska (Nebraska)**

2021 Summer Lot and Acreage Entry Information

* 6,789.2 acres entered for certification in summer
* 372 lots entered in summer
* PVY identified in 18 (3.5%) of lots.
* 17.32acres (1 lot) rejected during summer inspections and virus tests

2021 Winter Test Lot and Acreage Entry Information

* 1,531.65 acres removed = 5,257.55 acres entered into winter test
* 27 lots removed = 345 lots entered into winter test
* 46 lots not sent to the grow-out in Hawaii; sprout-tested instead

Planting in Hawaii

* 11/4/21-11/5/21
* 9.47 acre lot and 299 lots
* 106, 105 tubers were planted
* Good conditions at the time of planting

Visual Inspections and Virus Testing

* Conducted between 12/11/2021 and 1/3/21
* 86,945 leaves tested in Hawaii
* 89% emergence
* Testing conducted at the University
* of Hawaii
* Trained a new on-site leaf-picking crew

Sprout Testing

* 46 lots
* 12,365 tubers
* Some tested in Nebraska and some tested at other labs.
* Where most of the PVY was detected

Results

* 91% of lots passed
* 15 acres had PVY in virus tests
* Virus percentage ticking upwards since 2019
* 75% of lots testing positive had PVYNTN

**Tami Brown – Oregon State Seed Potato Certification**

She is taking over for Jeff McMoran who is retiring in September. Certified seed acres were at 3000 acres, up approximately 200 acres from 2020. A seed grower was lost because of lack of access to water and high temperatures. Field inspections went well. Clearwater Russet #1 in OR (338 acres. Red/pink skin varieties have increased to approximately 20%.

**Alan Westra (Idaho Crop Improvement Association (Idaho)**

Idaho acreage entered for seed potato certification increased 3.7% over 2020 to approximately 31,307 acres. Acres accepted for certification increased 2.9% over the previous year to 30,940 acres. Three was no leafroll observed during field inspections. A total of 7.6% of the seed lots entered for certification had some measurable amount of PVY during field inspections, compared to 4.2% of lots in 2020. Blackleg (*Pectobacterium* and/or *Dickeya*) continues to be a non-issue for Idaho seed growers, with low levels of incidence in the few seed lots that this was observed in. The ICIA seed certification laboratory has tested in excess of 3.7 million tubers as part of our screening program for BRR and there has not been a BRR detection since the 2015 crop. Post-harvest virus testing was conducted in Hawaii again this year. Overall, there was a significant increase in PVY levels compared to the 2020 crop, with PVY averaging 4.6% per lot and 3.93% per acre. This is a 4-fold increase over 2020 levels and is probably attributable to a significant increase in aphid populations (aphid trapping data provided by K. Kinzer).

**Nina Zidack, Potato Seed Certification Program (Montana)**

Montana’s 2021 Postharvest test recorded the lowest PVY levels in 10 years. Across all plots, 0.17% PVY was detected by ELISA and 0.12% Mosaic was visualized through inspection. This represents a 6-fold reduction in PVY from the peak year of 2017 where 1.01% PVY was the average across all plots. In 2018, multiple growers started exercising extreme isolation, keeping nuclear plantings distant from all other potatoes. In 2019, Montana PHT sampling structure was changed to increase sample number on G1 and G2. For G1 lots larger than 2 acres and G2 lots larger than 20 acres, growers are required to collect a minimum of 2 400 tuber samples. Growers are strongly encouraged to send one duplicate sample to the lab for tuber testing. In 2021 XXX samples were evaluated using direct tuber testing using immunocapture followed by RT-PCR. Results from direct tuber testing are similar to field grow out and are provide a reliable test to determine suitability for recertification. The combination of isolation of early generation plantings and enhanced data on G1 and G2 has resulted in lower virus incidence and better decision making by growers for recertification.

**Brooke Babler Wisconsin Seed Potato Certification Program (Wisconsin)**

In 2021, 9,499 acres of certified seed potatoes were planted, which was up from 9,294 acres in 2020. Our post-harvest test (PHT) was planted Nov 16-18 on Alger Farms, Homestead, FL, however due to three consecutive rain events our crop was considered a complete loss. A variance for certification based on summer and harvest inspections was provided upon the PHT loss. Laboratory testing was provided for lots needing out of state certification or if growers expressed concerns. Staff tested 74 lots via IC-PCR and 143 lots via a ELISA (PVY & PLRV) greenhouse grow-out. All results were released to growers by the end of February. Overall, WI growers had a great growing season, with only two foundation lots reclassified as certified. No lots were rejected in the PHT, but four foundation lots were reclassified as certified. No PLRV was found in any PHT lots. Renee Rioux commented that the greenhouse testing was huge undertaking by Brooke and her team and growers really appreciated it.

**Andrew Houser Colorado Potato Certification Service (Colorado)**

Colorado certified seed acres have dropped by about half over the last 15-20 years due to PVY rejections and other factors. There were 7,800 acres of certified seed that was planted in the 2021 growing season. This trend in acreage has had a negative impact on seed sales. However, the number of seed rejections during the summer field season has been decreasing over the last 5-6 yrs, due in part to consistent crop growth at the Post Harvest Tests in Hawaii and greenhouse (2020). Unfortunately, commercial potato fields in Colorado are planted in close proximity to many of the certified seed fields, resulting in a high amount of PVY spread from commercial fields to certified fields by aphids. To make matters worse, an early hail event in June, 2021 decreased the crop health in many fields, resulting in additional susceptibility of the potato plants to PVY. These are some of the factors that caused a high number of seed rejections at the Post Harvest Test this year.

There was close to 1,600 acres rejected at the Post Harvest Test this year, or about 20% of the certified seed crop. About 30% of the G1 (FY1) acreage was rejected, about 40% of all the Russet Norkotah sel. acreage was rejected and about 55% of the Reveille Russet acreage was rejected at the Post Harvest Test growout in Hawaii this year. Overall, when backup samples were sprout tested for PVY, they typically matched the Post Harvest Test results and came within a few % in most cases. The largest differences were when the PHT levels were >10% PHT in either the Post Harvest Test growout or backup sprout test. In those cases, both the Post Harvest Test result and the backup sprout result were over 10% PVY, resulting in a rejection of the lot.

On a positive note, rejections for G2 (FY2) seed have been decreasing over the last several years. In 2016, G1’s started to be tested at the PHT and the number of G2’s rejected in the summer dropped from about 60-80 acres (2015/16) to about 5-10 acres/yr (2020/21).

**Kent Sather North Dakota Seed Potato Certification (North Dakota)**

North Dakota certified seed acreage entered for the 2021 crop was 14,471 acres, down about 500 acres from the previous year. Thirty-eight acres were rejected, all due to PVY. Fifty percent of ND certified seed represents processing varieties. Twenty-six percent represent red varieties. Twenty percent represent round white varieties, and three percent are specialty potatoes. Due to a summer drought yields were down as much as 30%, but quality was good. Our post-harvest test plots were planted on schedule in mid-November. Heavy rains following planting drowned the plot completely, resulting in a total loss. The seed department requested back-up samples from growers for priority lots and those being shipped out of state. These samples were gathered and sprouted so the sprouts could be tested for PVY and PLRV. All lots are PLRV negative. All lots from isolated, early generation growers were negative for PVY. Some later generation lots exposed to commercial production did have PVY, ranging from 0.25% to 2%. As a default to the failure of the plot grow out, our North Dakota growers can replant for recertification any lot that passed the 2021 summer inspection. This is allowed with great discernment, as those previously exposed to PVY inoculum will likely have some levels expressing in 2022.

**10:00 am -------Break----------**

**10:15am Research Updates**

**Potato Virus Y**

**PVY strain composition in PNW potato, 2011-2021; Alex Karasev University of Idaho**

Lisa T. Tran1, Kelsie J. Green1, Mariana Rodriguez-Rodriguez1, Gardenia E. Orellana1, Cassandra N. Funke1, Olga V. Nikolaeva1, Arturo Quintero-Ferrer1, Mohamad Chikh-Ali1, Lynn Woodell2, Nora Olsen2, and Alexander V. Karasev1

1Department of Entomology, Plant Pathology and Nematology, University of Idaho, Moscow, ID; 2Kimberly Research and Extension Center, University of Idaho, Kimberly, ID.

Potato virus Y (PVY) exists as a complex of strains and changes in their prevalence were investigated in potato fields in the Pacific Northwest (PNW), including seed potato production systems in the state of Idaho, and commercial potato fields in the Columbia Basin of Washington State between 2011-2021. Between 2011 and 2016, the prevalence of the ordinary, PVYO strain in seed potato dropped 8-10 fold, concomitantly with the rise of recombinant strains PVYN-Wi and PVYNTNa, which together accounted for 98% of all PVY-positives by 2021. The remaining 2% were taken by another recombinant starin, PVYN:O. In Idaho seed potato, PVYNTNa strain associated with the potato tuber necrotic ringspot disease (PTNRD) was found to increase three-fold between 2011-2019, accounting for 24% of all PVY-positives in 2019.

**PVY-coded NIa protein modulates the auxin-signaling pathway and disease development**

Prabu Gnanasekaran, Ying Zhai, Hira Kamal, and Hanu Pappu

Department of Plant Pathology, Washington State University, Pullman, WA.

Several PVY-coded proteins were examined for their interactors in the host. For this purpose, a *Nicotiana benthamiana* cDNA library was screened using the yeast two-hybrid assay. The *N. benthamiana* *Indole-3-acetic acid-amido synthetase* (IAAS) was found to be one of the potential host-interacting partners of NIa protein. Transient silencing of IAAS reduced the susceptibility of *N. benthamiana* plants to mechanical inoculation by PVY, while overexpression of IAAS protein increased the PVY disease development. Additionally, the expression of auxin-responsive genes was found to be downregulated during PVY infection.

**Epidemiology of PVY in the NB seed potato industry: An update on PVY trends and factors driving its spread**

Tyler MacKenzie1\*, Suzanne Young2, Mitchell Smith2, Angela Gallagher1, Mathuresh Singh1

1Agricultural Certification Services, Inc., Fredericton, NB

2Potato Development Centre, 39 Barker Lane, Wicklow, NB, E7L 3S4

Potato is the most important agricultural crop in New Brunswick (NB), and includes a valuable seed potato industry used domestically and for export to other potato producing regions. Potato virus Y (PVY) is an important disease agent which has been a major focus of research and management in this industry. Through close cooperation of researchers, regulators and growers, significant advances in controlling PVY in the NB seed potato crop have been realized in the past decade. Since 2009, average post-harvest PVY in NB seed lots dropped from 11.8% to less than 1%, with a record low of 0.43% in 2016. A resurgence in 2017-18 doubled mean PVY level across NB, which has only slowly dropped to 0.55% by 2020; for the first time since that recovery, average PVY has begun growing again to 0.59% in the 2021 harvest. While changes in average PVY appear small, these shifts were indicative of large changes in PVY near the regulatory threshold for maximum allowed PVY in seed lots (currently capped at 4% PVY incidence). For example, the 2017-18 resurgence peaked with an increase of only ~0.7% but resulted in more than three times as many seed lots failing the PVY cap than in the previous four years of relatively low PVY – representing millions in lost revenue.

Our research group has amassed a large and growing data set of seed lot PVY outcomes, including potato variety, seed class, PVY in seed planted, local aphid and climate data and grower identity and management practices – amounting to nearly 7000 seed lots since 2009. Major trends over this time have impacted PVY spread and management, including a major consolidation in the seed production industry of varieties grown and number of commercial-scale growers. On average, ~103 potato varieties are tested annually for seed certification in NB; a decade ago, eight varieties made up over 50% of seed production acreage, dropping to only four varieties currently. Three of these four tested higher than average for PVY level. The largest, Russet Burbank, grew from 15% to 35% of acreage since 2009, with consistently higher PVY than average for other varieties in the past 6 years, with a trend that continues to diverge higher. At the same time, the number of commercial growers participating in the NB seed certification program dropped in half since 2009, while their individual production has increased. More of these growers produce both seed, requiring low PVY levels, and processing or fresh market potatoes, without constraints on PVY. Such growers have shown significantly higher PVY in their seed crops, compared to growers focused on seed production alone. Many growers express concern that many factors driving PVY spread are outside their control, such as climate variables, abundance of aphids which are vectors for PVY in their fields or recent shifts in PVY populations to more transmissible strains, or factors they have only limited influence on, such as PVY levels in the available seed supply to plant their fields. Our epidemiological modeling does indeed show the strong effects of these factors on PVY outcome industry-wide, however, equally important is the variation in PVY outcomes between growers after statistically accounting for all these other factors. Our analysis shows that management choices by each grower are sufficient to greatly reduce PVY in their fields, despite the effects from factors outside their control, and several specific management practices identified by our modeling will be discussed in this presentation. With these data and modeling efforts, factors associated with PVY spread, both at the industry-scale and by individual growers, can explain much of the great shift in PVY levels in potato seed crops in recent years, predict PVY outcome under specific growing conditions, and identify strategies growers can adopt to maintain low PVY in their crops.

**PVY Foliar and tuber symptoms associated with multiple varieties and strains. Jonathan Whitworth USDA-ARS**

Jonathan Whitworth\*, Stewart Gray, Jason Ingram, Darren Hall, USDA-ARS Aberdeen, ID and Ithaca, NY

An overview of testing varieties for the foliar and tuber reaction to Potato virus Y strains, PVYO, PVYNTN, PVYN:O, PVYN-Wi was given. Work was done in two greenhouses at Aberdeen, Idaho and Ithaca, New York. All PVY infections were primary with inoculations done by hand or spray inoculation. Plants were tested using ELISA ~3 weeks post-inoculation. Foliar symptoms were recorded weekly and at harvest tubers were examined for Potato Tuber Necrotic Ringspot Disease (PTNRD). Greenhouse screenings of primary infections and examination of the daughter tubers was done on 66 varieties and using multiple PVY strains and isolates. PTNRD was evident in 19 varieties. Of those, 10 had tuber symptoms associated with O, 9 had tuber symptoms associated with NTN, 8 had tuber symptoms with N:O, 12 had tuber symptoms with N-Wi. A poster is available which shows the tuber reactions with varieties grouped into four market classes (Russet, Red, Chip, and Specialty/White).

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**PVY-triggered metabolic adjustments in potato: An update**

Richard Manasseh and Hanu R. Pappu

Department of Plant Pathology, Washington State University, Pullman, WA.

The metabolomic response of PVY resistant and susceptible cultivars to different PVY strains is being studied. Using a mix of univariate and multivariate analysis tools, at least 28 differentially expressed metabolites were found - belonging to various compound classes, including vitamins, esters, amino acids and polyamines, organic acids, sugars, sugar alcohols (polyols) and sugar phosphates. In both cultivars, both common and strain-specific metabolic shifts seem to underpin the host response to PVY.

**11:30 Open Discussion**

PVY modeling conducted in New Brunswick was discussed. This included rogueing practices, isolation of seed-growing areas and the application of crop oil. Sprout testing was also discussed. The size and number of sprouts as well as testing composite samples.

**12:00 pm Lunch**

**1:30 pm Research Updates**

**Updates in Diagnostics**

**Dormant Tuber Testing: Lessons Learned and Future Prospects - Jason Ingram USDA-ARS**

*Single slide highlights of challenging developments in dormant tuber testing; designed to open tavern discussion for those lucky enough to attend WERA 2022 in person.* ***Sensitivity and Specificity*** *- continued advances in tuber testing methods will shift the metric of a good test beyond what has always been the first hurdle of the “false negative rate” and how we plan for beyond that.* ***Flexibility*** *–Stakeholders have requested more information that could be collected using expanded dormant tuber tests to aid in farm decision making.* ***Scalability*** *- Preliminary (incomplete PHT) results for 2021 dormant tuber tests; and how to collect a large and geographically diverse dormant tuber test data set in 2022.*

Sensitivity and Specificity of the dormant tuber test for PVY were measured by comparing the 1step RT-qPCR result for PVY on a 25-tuber pool collected on an FTA card to the leaf ELISA from the same serialized 25 tubers (grown and tested as 5 leaf ELISA groups).

A cutoff Threshold Cq for absence/presence of PVY was based on 77 PVY viral copies (IDT gBLOCK) included as template in two control wells on each qPCR plate. Using that threshold; Sensitivity was 93.5% (PCR correctly detecting PVY in 93.5% ELISA positive groups). Specificity was 94.8% (PCR not detecting PVY in 94.8% of matched ELISA Negative groups) out of a total of 576 total sample pool results available for 36 of the 39 seed lots (at meeting time) from 4 States and discussed adjusting the viral copy number threshold on a plate to adjust the Sensitivity and Specificity tolerances more conservative or liberally. For 2021 Data, 66% of “False Negatives” (10/15) were attributed to 3 seed lots from one farm and 66% (12/18) of “False Positives” were attributable to three seed lots from a (different) single farm.

qPCR data was also collected for PMTV and TRV on those seed lots, but follow up sprout testing for those two viruses could not be completed.

Outlined industry interest in adding pathogens (*Clavibacter*, *Spongospora* and Stubby Root Nematode) of interest to Agronomists, (not necessarily seed certification) using the seed lot as a “trap crop” to test fields for soil born pathogens or other seed transmitted pathogens.

Described a grant funded for 2022 Fall Harvest for Dormant tuber PVY testing on the farm. Seeking cooperators at 2 seed farms in each of 15 seed potato states, 4 seed lots per farm. Funded by APHIS PPA 7721 – *Automation scalability for direct testing of potato tubers to safeguard US seed potato health. Lead by Filiatrault, Naughton, Charkowski and Mattupalli*

**Emerging technologies for the detection of plant viral diseases - Derrick Grunwald University of Wisconsin.**

SHERLOCK (specific high-sensitivity reporter unlocking) is an emerging method for detecting plant diseases. In this method, nucleic acids are detected by first amplifying target sequences by recombinase polymerase amplification (RPA) and second by cleavage of a reporter probe by a Cas13 enzyme. The method is sensitive as it leverages RPA chemistry to detect target nucleic acid sequences at the attomolar level. SHERLOCK circumvents the inherent false-positive rates of RPA as the detection probe is cleaved only when a Cas13 enzyme is guided to its target sequence by a 28 base-pair guide sequence. This method has begun to be developed for potato leafroll virus with plans to adapt this method to detect potato virus Y at the strain level in a multiplexed fashion.

**Alice Pilgeram, Montana Seed Certification**

The goal was to streamline PVY strain ID as much as possible using protocol modifications. ELISA was conducted on 482 samples that tested positive in winter grow-outs. Positive samples were verified using ELISA and strain ID was conducted using the modified protocol. Can we use rt-PCR for PVY strains? Attempted to find other primers that distinguish NTN from other strains. Kogovsek (2008) primers amplify both NTN and Wilga. A melt curve analysis can be conducted with probe-based PCR. The Kogovsek and Burger primers give separate melt curves and can differentiate for strain ID. Some residual melt curves were observed and Wilga would mask NTN in samples with mixed infection. Timing of dormant tuber testing was also evaluated and detection increased with increasing time (at delivery, 3 and 6 weeks post-delivery). Attempts were unsuccessful to develop an immunocapture assay for PMTV. Four sets of PMTV antibodies were evaluated.

**2:00pm Open Discussion**

**2:15pm Research Updates**

**Powdery scab / Mop-Top**

**Integrating environmental sensing and molecular pathogen detection methods for improving powdery scab disease prediction in the U.S. – Yuan Zend PhD CSU**

Data obtained from the three field trials conducted in 2017-2018 on potato powdery scab (Zeng et al. 2021) revealed that powdery scab incidence, but not *Spongospora subterranea* (Ss) soil sporosorus density changes, correlated with on-farm irrigation levels. Thus, Charkowski’s group at CSU is integrating environmental sensing technology and model-based forecasting approaches into potato powdery scab management.

In 2021, field trials were conducted in 16 naturally Ss-infested fields in Colorado, North Dakota (Dr. Julie Pasche), Minnesota (Dr. Julie Pasche), Oregon (Dr. Kenneth Frost), and Maine (Dr. Bee Chim). Within each field, sensor units that measure on-board temperature and relative humidity as well as soil temperature and moisture were installed in four different locations to collect data every 30 min from plant emergence to vine-killing or senescence.

Soils were sampled prior to planting to determine soil chemical properties and textures in each location. A Principal Component Analysis (PCA) on the soil physicochemical characteristics revealed that there is a dissimilarity between Maine soils and soils from other states. In addition, Colorado soil sample data overlapped those of North Dakota, Minnesota, and Oregon.

Soils that were sampled prior to planting and monthly after planting until harvest were used to determine Ss sporosorus density using a quantitative PCR assay. The data collected from Colorado fields, as an example, showed that Ss sporosorus inoculum density displayed a spatial heterogeneity within a field, and the Ss sporosorus density generally increased after July or August. In addition, at certain sampling dates within a field, a reduction of soil inoculum was observed, suggesting zoospores either died or released from soil sporosori and infected host plants roots, stolons, or tubers.

Roots were sampled for root gall assessment before vine-killing or senescence. Interestingly, galls were observed on all cultivars, including Austrian Crescent, Yukon Gold, Russet Norkotah, Soraya, Umatilla Russet, Russet Burbank, etc. The severity of root gall formation seems to correlate with root susceptibility to Ss and/or initial soil sporosorus density level. In addition, the number of root gall/gram dry roots positively correlates with soil sporosorus density changes in Oregon, Colorado, and North Dakota, but it negatively correlates with soil sporosorus density changes in Maine and Minnesota.

Comparing environmental sensing data in a field (Roggen) in Colorado to that in a field (Caribou) in Maine where yellow-skinned cultivars were planted (Austrian Crescent, Yukon Gold, and Soraya) suggest that on-board relative humidity (indicating plant or canopy size), soil temperature (the length of conducive soil temperature 10-20 C), volumetric water content (higher VWC when plants are bigger—higher root biomass & tuber presence) are factors that drive powdery scab disease incidence and severity.

Yuan only performed very simple statistical analysis. No forecasting model(s) yet, but hopefully soon!

Trials will be repeated in 2022 growing season to build a robust forecasting model.

**Studies on the roles of PMTV proteins using a PVX-based expression system - Hira Kamal WSU**

Hira Kamal, Natalia Moroz, Kiwamu Tanaka, and Hanu R. Pappu

Department of Plant Pathology, Washington State University, Pullman, WA.

The potential roles of various PMTV genes in pathogenicity are being studied using a Potato virus X-based expression vector. The coat protein (CP), triple gene block (TGB)-2 and TGB-3 genes of PMTV were expressed in *Nicotiana* *benthamiana* and their effect on plant phenotype were monitored. Plants expressing the CP showed severe symptoms with leaf crumpling and downward curling and yellowing in newly emerging younger leaves, and stunting, while plants expressing TGB-2 or TGB-3 developed milder symptoms. When CP and TGB-3 were expressed together, plants produced a hypersensitive response (HR). These results suggest that CP plays a potentially important role in symptom development during PMTV infection.

**Minimally biased pathogen detection: a case study with powdery scab-infested soil - Kiwamu Tanaka WSU**

Early detection of causal pathogens is important to prevent crop loss from diseases. However, some diseases, e.g., soilborne diseases, are difficult to diagnose due to the absence of visible or characteristic symptoms. In the present study, the use of the Oxford Nanopore MinION sequencer as a molecular diagnostic tool was assessed due to its long-read sequencing capabilities, portability, and inexpensive costs. Nucleotide samples from potato field soils infested with powdery scab pathogen were sequenced and analyzed with a program we developed using a locally curated database. The data collected demonstrate the high potential of MinION sequencing as an on-site, minimally biased diagnostic tool for comprehensive pathogen detection in soil from potato fields.

2**:50pm Open Discussion**

**3:00pm Research Updates**

**Tobacco Rattle Virus**

**Understanding Tobacco rattle virus epidemiology through basic and applied assays - Kylie Swisher Grimm USDA-ARS**

Question 1: Does planting seed with TRV/CRS affect tuber sprouting and the development of daughter tubers? TRV seed transmission was evaluated visually in four treatments (asymptomatic, mild, moderate, severe). These assessments were complicated by PVY. Emergence was comparable regardless of cultivar and TRV infection. Daughter tubers harvested from a single plant displayed a range of internal necrosis symptoms. Severe symptoms in seed piece did not correspond to severe symptoms in daughter tubers.

Question 2: Does TRV infected seed and the presence of TRV infected SRN in the soils cause below ground twisting and delayed emergence? Stem deformity and thickness were measured. Emergence in the SRN field was delayed by approximately one week but was not associated with infection status of seed. Below ground symptoms were not consistently correlated with seed infection status or field status in both years the study was conducted. Stems were thicker in SRN infested fields in both years but was not affected by seed.

Question 3: Does TRV move systemically through the root system of an individual plant? A split plot design was implemented where seed was planted above the 2 pots, with half of the roots in each plot. One of the two pots was inoculated with SRN-TRV. Plant were harvested 8-12 weeks post-inoculation. In two trials, soil in non-infested pots remained SRN-free. TRV was not found in the roots system of non-infested soil, indicating that TRV infection is localized.

Question 4: If stubby root nematodes are depleted from soil, do corky ringspot symptoms continue to increase? Conclusion from greenhouse trials indicate that TRV-infected seed leads to higher RCS in daughter tubers and that SRN (not TRV infection in seed) cause a slight delay in emergence.

**3:40pm -------Break--------------**

**4:10pm Research Updates**

**Cultivar Development**

**TRV marker development - Sagar Sathuvalli Oregon State University**

Corky ringspot (CRS) disease caused by tobacco rattle virus (TRV) and vectored by stubby root nematodes, can render 6-55% of potatoes in an infested field unmarketable. Previous studies identified 22 SNP markers that are significantly associated with CRS resistance from ‘Castle Russet’ using a progeny of 48 seedlings. In this study we developed 44 pairs of PCR primers around previously identified significant SNPs. SNP marker PotVar0108448 on chromosome 9 shows polymorphisms on agarose gel electrophoresis and explains the highest percentage of phenotypic variance. Based on the initial marker screening, we developed 36 pairs of SSR primers, 72 pairs of primers for short INDELs and 36 pairs of primers for long INDELs on the upstream and downstream of SNP marker PotVar0108448. We screened them on 48 seedlings of progeny POR15V001 and 170 seedlings of progeny POR16V001. Markers INDEL20, INDEL490-7, Potvar008448 are linked to CRS resistance from ‘Castle Russet’. Of these, marker INDEL490-7 was robust and able to identify resistance from diverse germplasm. It has the potential for use in marker assisted selection

**Multiplex PVY marker assay - Greg Elison USDA-ARS**

Three natural sources of resistance to PVY; *S. stoloniferum* (Ry sto), *S. tuberosum* ssp. *Andigena* (Ry adg), and *S. chacoense* (Ry chc) have been introgressed into a few PVY resistant varieties widely grown in North America. Why aren’t we growing more PVY resistant varieties? PVY resistance is hard to breed for, is not easy to track / is a difficult trait to evaluate, and is associated with undesirable traits from wild potato relatives. It takes several generations to get a high-quality russet. Virus resistance generally is not a high priority from breeding programs. Current high-quality resistant varieties essentially just happen to also contain a PVY resistance gene. There is a need for easier selection. In Aberdeen, 100,000 seedling tubers are planted every year, 1500 are selected for year 2, approximately 200 clones are kept for replicated trials in year 3 and in years 10+ 0-2 clones released. Marker-assisted selection allows use of PCR to screen for a genotype. It is easier then field evaluations and can be done while plants are growing prior to selection. There are some draw-backs, a unique marker is needed for every resistance source, and about 1-2% of time the marker separates from the actual gene.

More recent PVY resistant varieties are not being adopted [e.g. Saginaw Chipper, Fortress Russet, Payette Russet, Lady Liberty (Chip), Mackinaw (Chip)], especially russets. Most new varieties are not successful, older varieties are still widely grown. Virus resistance remains a low priority with other traits becoming exceedingly more important to breeders.

PVY resistance was mapped in Sante. A susceptible clone from Sante was crossed with Bistra (Resistant) and were 190 clones planted, inoculated with PVY, ELISA tested, SNP genotyped, linkage maps developed, and a good QTL was identified.

The Future - Option 1: improve marker assisted selection. Option 2: treat PVY resistance as an essential trait. Option 3: integrate PVY resistance into breeding program at fundamental level so nearly all crosses will generate clones with PVY resistance.

**8:00am Call to order**

Renee Rioux was nominated to serve as Secretary. Kasia Duellman moved to elect Renee Rioux, Seconded by Alec Karasev. Unanimously approved.

9:00am Group Brainstorming Discussions – Research and granting opportunities.

9:30am Group Brainstorming Discussion 3–5-minute reports

Max F. inquired if other issues than virus or things we have not discussed we should be discussing annually at this meeting. Some discussion followed concerning the WERA mission to focus on viruses.

Breakout sessions included cultivar development, seed certification, PMTV/TRV. Discussion followed concerning group composition including grouping cultivar development and PVY.

Seed certification: Adam W. reporting

The discussion surrounded sites for winter testing including Twin Bridge Farms, Coretva, or other locations on Oahu. Successes and challenges Dormant tuber testing were discussed. Kent mentioned new hiring of Presley and his interest in investigating dormant tuber testing. Tammy Brown, OR indicated they do GH trials and the growers are happy with results. The bulk of the discussion involved using smoked gibberellic acid to break dormancy in place of bromo ethane and rindite. Nora’s group in ID worked to set up trial to break dormancy with smoked GA. Training has been proposed around dormant tuber testing to get away from winter testing in MT next fall and WI next spring.

Cultivar development and breeding: Joe reporting

The discussion focused on PVY in MI and other breeding programs. Fix andigina PVY resistance in germplasm so every cross has at least one PVY parent and new releases have resistance. PMTV and TRV are not as high on the list in MI but they are involved in marker work. Resistance to TRV and PMTV are more complex. New varieties are screened in Europe than in US. Growers are doing more cultivar optimization here. Other necessary resistances include PLRV. This may be driven by sustainability requirements from McDonalds and Walmart. Increased demand for IPM. This may provide an opportunity for larger players on processor side to call for varieties with resistance. We need more demand from processors. Joe commented on the long process (10-12 years) for variety development and the reality is more complicated due to the seed production pipeline. A few programs are trying to redesign how potato breeding is done but this is a very unpredictable process. As many as 30 traits to select for. A diploid system will hopefully make the process simpler. Some yields are comparable to tetraploid, but still working on cultivated package. A diploid system would reduce time to incorporating new traits, including disease resistance.

PMTV/TRV: Amy C. reporting

The focus was on PMTV, TRV was not discussed. The group is not very satisfied with high-throughput PMTV detection, PCR is not ideal. There is a need for improved tools but there are no real solutions at this time. There is also a need to determine Where PMTV is and where there are spongospora populations that lack PMTV. There are problems with detection limits not being sufficient to ensure the pathogens are not there. We cannot accurately track Spongospora / PMTV in new fields. There are also unknowns around virus and Ss diversity. More information is also needed on the physical soil characteristics that can promote the disease Spongospora in addition to soil moisture and temperature. What is the role of root galls in increasing soil inoculum and how is the virus moved through the plant? Suggestions were made surrounding the idea of suppressive soils. This group need more time to discuss. There are a lot of questions and not a lot of answers.

Announcements:

Requesting input of where to hold the 2023 meeting. Alex indicated that is was common in the past to rotate between Tucson and San Diego. Discussion following about other factors to be considered including access to technology to allow for on-line participation and the costs associated with renting space. The WERA leadership will conduct a survey next fall.

Mark made a motion to adjourn, Nora seconded. Unanimously approved.

10:00am WERA89 Adjourn