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Identification by Deep Sequencing of a "Caul imo-like" Virus in a Potato Botanical Seed Germplam Accession Imported from South America

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In the last 6 years, the USDA-APHIS Plant Germplasm Quarantine Program intercepted several uncommon viruses in potato germplasm accessions imported from around the world. One virus isolated from seedlings germinated from botanical potato seed, imported from South America, was detected through the use of molecular and biological testing procedures. About 3 % of the seedlings from this accession showed severe upper leaf deformation and necrosis. Tests included; Bioassay, ELISA, RT-PCR, and qPCR for most of the known viruses affecting potatoes. The virus induced a mild but conspicuous systemic vein clearing only on *Nicotiana tabacum* cv Samsun, indicating that it is difficult to transmit mechanically yet the virus was readily transmitted to potato and tomato plants by grafting. Tubers harvested from infected plants did not show any symptoms, but plants grown from these tubers developed necrosis, leaf deformation and rugosity. Small-RNA deep-sequencing analysis was used to assemble several contigs larger than 700 bp. BLAST search against virtual viral sequences showed identities higher than 90 % with *Cauliflower mosaic virus*, suggesting the presence of a "caulimo-like" virus. Sequence analysis of amplicons generated with specific primers designed from the contigs confirmed the presence of "caulimo-like" virus. A potentially dangerous seed-transmissible pathogen infecting potatoes was intercepted before importation at the USDA-APHIS-PPQ Plant Germplasm Quarantine Program, thus preventing the introduction of a putative unknown foreign potato pathogen into the USA.

Genome-wide Prediction of Antimicrobial Peptides from Potato and Assessment of Their Role in Disease Resistance

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Bacterial, fungal and oomycete pathogens cause serious economic losses in potato (*Solanum tuberosum* L.). Despite the continued release of new cultivars, sustainable management of pathogens is one of the most challenging issues in potato production. Transgenic plants expressing the genes encoding antimicrobial peptides (AMP) has shown potential in mitigating disease loss in potato. Using the available potato genome sequence, we identified AMPs in potato using bioinformatics analyses. Preliminary analyses of revealed that the potato genome encodes a diverse set of antibacterial and antifungal peptides. Compared to non-antimicrobial peptides, antimicrobial proteins are enriched for cysteine and glycine residues. We will use a transgenic approach to express predicted AMPs in potato an effort to create plants resistant to a broader spectrum of microbial phytopathogens. Development of transgenic plants expressing diverse AMPs may provide broad-spectrum

QTL analysis with TetraploidMap software revealed significant QTL peaks for chipping color on chromosomes 2 and 10, and significant peaks for specific gravity on chromosomes 4 and 5. These QTL may prove useful for marker-assisted selection of chip color and specific gravity.

Limiting Irrigation on 'Atlantic' Potato: Comparison of 2012 to Earlier Years

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Droughts are common in western Nebraska and most districts are under well-water allocations and potential surface-water restrictions. In 2009, a 4-year study began to determine when limited irrigation should occur for the least impact on plant growth and yield using the chip cultivar Atlantic. Irrigation was reduced by 15 cm, adjusted for rain, at different times during the growing season. The findings from 2009 to 2010 were presented earlier and those of 2011 were similar. But, in 2012, western Nebraska experienced a severe drought with high temperatures and low relative humidity. The findings of 2012 will be compared to that of the previous, more average, years. In summary, although exposed to the same irrigation regimes as previous years, in 2012, plants were substantially smaller, weighed less, flowered later, yields were halved, specific gravity was lowered, and chips were darker. The comparison of years under limited irrigation with climate extremes will promote a better understanding of plant's water response under drought conditions with high temperatures and low humidity. Growers forced to reduce irrigation of potato will understand how to better manage available water.

BRS Clara: A Fresh Market Potato Cultivar with Resistance to Late Blight

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BRS Clara is a new, medium maturing, and high yielding potato cultivar, having foliar resistance to late blight infection. Released in 2011, it was developed by the Embrapa Potato Breeding Program. The tubers have white and smooth skin, cream flesh, long oval shaped and shallow eyes. BRS Clara yielded similarly and sometimes higher than Agata, the most cultivated variety in Brazil (70 %). The superiority of BRS Clara was related to its resistance to late blight. The specific gravity was higher than Agata, and lower than Asterix (French fry variety), respectively in the autumn and spring season crops. It show low incidence of physiological defects, and moderate resistance to tuber greening. In relation to the main culinary uses, it was rated as good for boiling, and lightly good for baking. It showed moderate to high resistance to late blight, what makes it attractive to organic production, even though fungicides or alternative products for disease management in case of conducive weather. Field observations indicate that BRS Clara has moderate resistance to early blight, and susceptibility for PVY and PLRV. In general, crop management practices are the same as for medium maturity varieties. For maximum quality tubers, the harvesting point must be carefully observed, aiming to identify the time that combine maximum yield without loss of skin quality.

Potato Breeding and Cultivar Development in Brazil

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In Brazil, potatoes are grown between 31°S and 13°S latitude and between 19 m and 1,360 m altitude, with planting dates happening every month of the year. The total growing area is about 140,000 ha with an average yield of 26 $t.ha^{-1}$. Close to 90 % of the area is planted with foreign cultivars, and almost all do not meet processing industry or consumer requirements as well as are not well adapted to grow in Brazilian ecosystems. To reach high yields these cultivars require high use of inputs, making the production costs very high. So it is necessary to develop varieties in Brazil. In this sense Embrapa (the Brazilian Agricultural Research Corporation) has reorganized its breeding program. The program objectives are to develop high-yielding, early maturing, improved tolerance to biotic and abiotic stress cultivars, focusing the demand of the producing regions and consumer markets in the country, either for fresh table-stock or processing. Conventional methods supplemented with molecular techniques are used. Yearly, close to 60,000 new seedlings are included in the selection process. Hybrid populations are selected for horticultural and quality traits for four generations. Then, the selected clones are tested in yield trials as well as evaluated for quality and tolerance to main biotic and abiotic stresses. Clones showing potential to

become new cultivars are validated by collaborator growers and simultaneously tested for registration. The approved ones are registered, protected and released as named cultivars. Since the inception of the reorganized program in 2004, three cultivars have been released: BRS Ana in 2007, BRS Clara in 2010, and BRSIPR Bel in 2012.

The Role of Lipoxygenase and Patatin-lipase in Powdery Scab Disease Tolerance in Potato Tubers

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Some of the storage proteins like lipoxygenase and patatin are known to play a role in defense mechanism against certain diseases and insects in plants. In general, potato genotypes with russet skinned tubers are resistant to tuber powdery scab disease (*Spongospora subterranea* f.sp. *subterranea* or *Sss*). The objective of this study was to find out the role of these storage proteins in powdery scab resistance in potato tubers, particularly in russet skinned potatoes. Our results suggest that the russet skinned tuber genotypes (Mesa Russet, Centennial Russet and Russet Nugget) with negligible tuber disease severity index (DSI) and 100 % marketability were resistant to tuber powdery scab during green house screening of potato germplasm over several years (2006–2011). Higher levels of LOX protein on a dry weight basis (physiological levels) were negatively correlated with tuber DSI and positively correlated with tuber russet skin. Tuber total protein and patatin-lipase levels did not have a significant relationship with tuber powdery scab resistance. We have proposed the role of LOX protein in suberin- and/or non-suberin-mediated mechanisms of powdery scab resistance in russet skinned tubers. The physiological levels of LOX protein may be considered as a useful marker for powdery scab tolerance in potato breeding programs.

Variation in Aggressiveness of Genotypes of *Phytophthora infestans* Found in Eastern Canada

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Late blight, caused by *Phytophthora infestans*, has caused extensive damage to potatoes and tomatoes in eastern Canada in recent years. Surveys conducted in 2011 and 2012 have documented a shift in the composition of pathogen populations in eastern Canada, with new A1 strains (US-23 and US-24) largely displacing the formerly dominant A2 strain (US-8). Greenhouse and storage trials were established in 2012 in an attempt to compare the pathogenicity and aggressiveness of the new A1 strains with the former A2 strain on a variety of host plants. Various cultivars of potatoes, tomatoes, peppers and petunia were inoculated with sporangia of one of the pathogen genotypes (or water only as a control) in a replicated greenhouse study and then monitored for disease expression and pathogen sporulation on host tissues. Similarly, a storage trial in which tubers of various potato cultivars were inoculated with sporangia of one of the pathogen genotypes (or water only as a control) in a replicated study was also established. US-23 caused significantly more disease on tomatoes than US-8 or US-24, but was less aggressive on potato foliage than these two genotypes. However, US-23 and US-24 were equally or more aggressive than US-8 in generating rot in inoculated tubers. Host × pathogen interactions were significant in both greenhouse and storage trials, indicating that some host-strain combinations were more conducive to disease development than others. Elucidating some of the biological characteristics of novel genotypes of *P. infestans* in Canada will provide commercial growers and home gardeners with information to make better disease management decisions.

Comparison of Three Potassium Fertilization Programs for Processing Potatoes

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Potassium fertilization can have strong effects on potato yield and quality. Fertilizer costs have increased dramatically in recent years and this has stimulated renewed interest in more efficient use of fertilizers. This project was designed to test whether a "sufficiency level" approach for K_2O fertilizer recommendations could provide comparable yield and quality to the "build and maintain" approach recommended by the University of Maine for many years. We also evaluated a new program that included low rates of at-planting K_2O followed by soil- and foliar-applied potassium thiosulfate (KTS). Six experiments comparing these programs were conducted during 2011 and 2012 using representative fry processing (Russet Burbank) and chipping (Atlantic) potato varieties. The 2011 and 2012 results demonstrate that the "sufficiency-level" approach can be used to provide modest potash savings relative to the "build and maintain" approach (~67–90 kg/ha) on soils that have moderately high to high potassium fertility; however, the data do not support decreasing at-planting potash rates to the lowest levels used in these experiments (17–67 kg/ha