Building a Better Potato – tuber greening resistant

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ABSTRACT

Green potatoes are not desired by consumers nor the potato industry. However, tubers frequently will turn green after exposure to light. *Solanum microdontum* (mcd), a wild potato species, resists tuber greening. Therefore, a population was created between a known tuber-greening resistant mcd and cultivated potato susceptible to greening, to study the genetics of greening resistance and the accumulation of tuber glycoalkaloids. This population is also being evaluated for frost resistance, dormancy, and photoperiod characteristics. The overarching goal of this work is to develop russet potatoes that resist greening after exposure to light through laboratory techniques and breeding by capturing desired genes\traits and moving them into advanced lines.

Figure 1: Two random tubers selected from each individual clone were exposed to constant illumination for four days.

Figure 2: Visual variation in tuber greening study between a greening resistant and greening susceptible tuber after illumination.

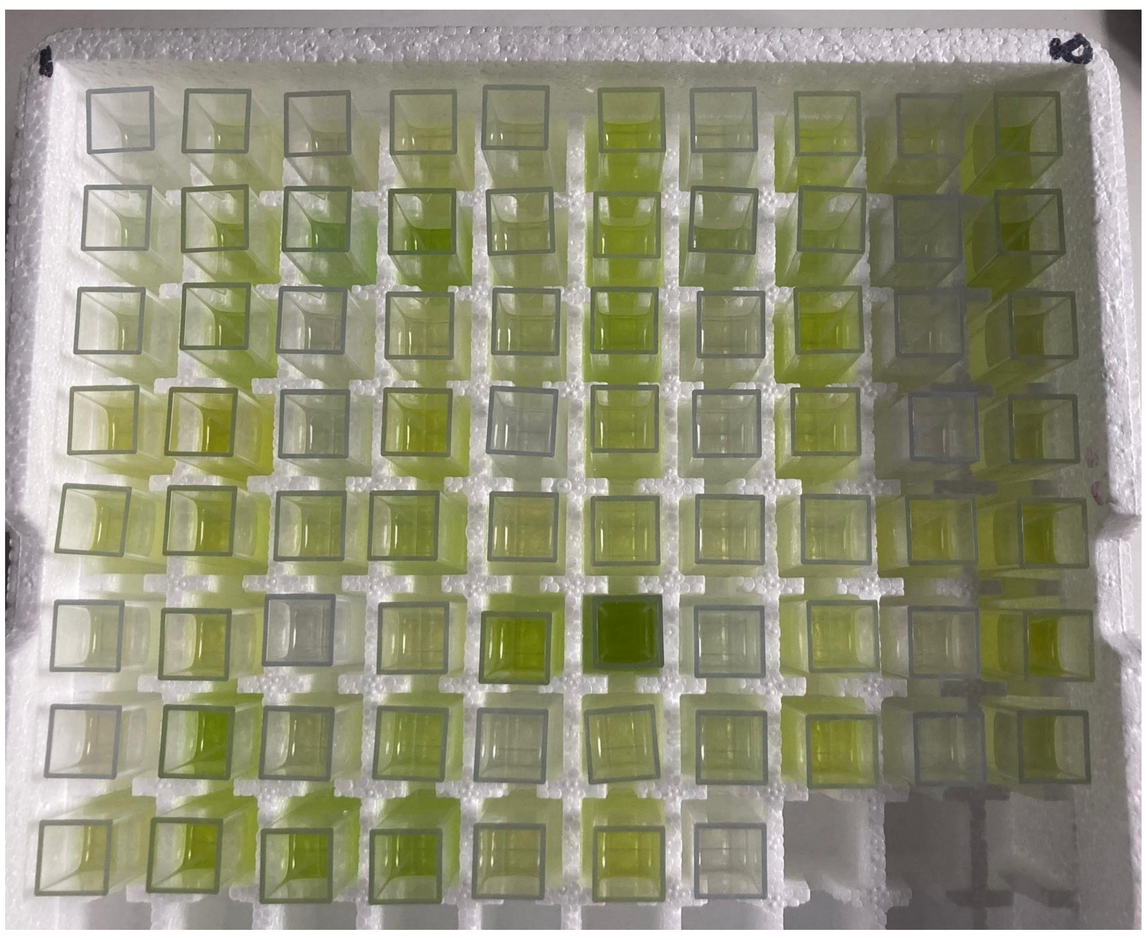

Figure 3: Chlorophyll samples for a set of 77 different MCD tubers with varying degrees of chlorophyll content.

OVERVIEW

Tubers are exposed to light source in the field during the growing season (not covered with soil or during harvest), in processing, and in the marketplace for sale under standard lighting. This exposure to light begins a reaction that produces green pigment (chlorophyll) in the tubers for light capture and energy production through the process of photosynthesis. This greening of the tubers results in poor tuber quality and economic loss for the industry. Using a population derived from the intercrossing of a tuber-greening resistant mcd hybrid with cultivated potato, the progeny were studied to identify the gene or genes responsible for the resistance to tuber greening.

The population was grown out for three years (2021, 2022, and 2023) and tubers were collected from the parents and the progeny. Four tubers from each individual clone were chosen with two tubers being randomly placed into a growth chamber under constant illumination for four days (Fig 1 & 2), while the other two tubers were kept in the dark. After light treatments, the tubers were freeze dried and ground for further analysis. Since chlorophyll is the source of "greening" due to light exposure, the extent of greening was determined visually and by extracting chlorophyll from each of the samples and quantifying the amount of chlorophyll a, chlorophyll b, total chlorophyll, and carotenoids that were present in each of the samples (Fig 3 &4). To extract chlorophyll, 0.25g of freeze-dried potato powder was combined with 95% ethanol and incubated for 12 hours. The liquid (ethanol with suspended chlorophyll) was drawn off each sample, filtered, and read at 470, 649, and 664 nm using a spectrophotometer. Using these absorbance values, chlorophyll a, chlorophyll b and carotenoid content was calculated in ug per 0.25g of dry weight. The tubers were also analyzed biochemically for the presence and different types of glycoalkaloids (bitter compounds, sometimes toxic), since greening has been suggested to be associated with glycoalkaloids. DNA of each individual was isolated and sent to a service provider for DNA fingerprinting with the Infinium SolCap SNP array. The fingerprinting data and the tuber greening data were put together for analysis with the goal of finding a gene or genes involved in tuber greening resistance, along with advancing the development of a laboratory-based test that could be used to quickly screen for this greening resistance in our breeding lines at the USDA ARS Small Grains and Potato Germplasm Unit in Aberdeen, ID.

Figure 4: Side by side image of a high chlorophyll sample (tuber greening susceptible) and a low chlorophyll sample (tuber greening resistant).

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