Colorado Potato Administrative Committee, Area II
Proposals for 2014-2015

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Postharvest physiology and storage techniques

Title: Pressure Bruise management – Testing and verifying pressure bruise management protocol
Variety-specific storage guidelines – Storage recommendations for newly released varieties

Most-relevant funding source: CPAC-Area II

Executive summary: Over last four years of our research concluded that the tuber hydration is one of the most important and manageable factors among other aspects such as pile height and duration of storage in reducing pressure bruise incidence. We developed a ventilated crib design to induce pressure bruise in potato tubers under laboratory conditions. We identified texture analysis is the most accurate way of measuring the tuber hydration status and developed a correlation between pressure bruise incidence and texture. Based on this research, we developed a at-harvest test to predict the pressure bruise incidence.

Nature and scope of proposed research: The proposed research program will focus on understanding the effects of moisture loss, shrink, texture, pressure bruise incidence and stored potato quality of russet potato cultivars and also specialty cultivars coming out of breeding programs.

Pressure flattening occurs as potatoes are stored in bulk storage bins and exposed to pressure over time from the weight of other potatoes in the pile. The weight of the potatoes is transferred to the individual potato at the points of contact with adjacent potatoes or with the storage structure itself. The physical deformation of the tubers due to these pressures comes from the crushing of the outer layers of periderm and underlying cells. The height of the pile in which the potatoes are stored and the duration that they are stored, therefore, become critical to determining the accumulated pressure to which the tubers are exposed.

Tuber moisture loss causes economic losses due to increased susceptibility to pressure bruising of potatoes stored in the fresh market (Jayanty, 2009). Water loss occurs by evaporation from the periderm, and rates of water loss can be rapid before skins are fully suberized. Rehydration of tubers in soil possible only when free water is available. As skins, mature suberization of the periderm dramatically restricts the potential for water uptake by tubers and may prevent appreciable rehydration late in the year. Data documenting the influence of pre- and postharvest practices on tuber hydration and associated cellular turgor pressure, however, are lacking. Data are needed to define relationships between tuber hydration status and pressure bruise incidence and methods are needed to quantify the effect of preharvest and postharvest management practices on tuber hydration and turgor pressure.

The texture analyzer was used to determine peak load required for surface tissue deformation, Brookfield CT3 Texture Analyzer equipped with a TA Bt kit and a T18 spherical probe (Brookfield Engineering Laboratories, Inc. Middleboro, MA. USA). The 3mm. Target deformation depth was thought to correspond well to the depth of the periderm and underlying cells that would be crushed by pressure flattening in commercial storage. In 2011 and 2012, texture analysis, testing was done using tubers of 3 russet cultivars to determine the sensitivity of the texture analyzer to moisture loss (as percent weight loss) from the tubers. As the tubers lost weight, the tubers were separated into groups based on half-percent moisture loss intervals (+/- 0.15%). We tested in two commercial operations the relationship between texture and susceptibility to pressure bruising in 2012 and 2013.

Our research using texture analyzer concludes that

1.Peak loads were different between tubers that were differentiated by as little as 0.5% weight loss due to dehydration.

2.Texture analysis showed differences in at-harvest peak loads between separate varieties that may be related to varietal susceptibility to early development of pressure flattening.

3.Peak load differences were observed between fields of the same variety and exceptionally lower peak load fields within a variety often were found to have had problems related to fertility or crop maturity that were observed during the growing season.

4.Based on correlations observed between at-harvest peak load and pressure flattening after storage, there was a strong, although imperfect, correlation between higher peak loads at-harvest and lower pressure flattened area per tuber after 6 months storage duration.

5.When multiple fields and varieties are tested at harvest and grouped into halves or quartiles based on peak loads, on average, fields in the lower halves and quartiles will have significantly more pressure flattening after a common duration of storage, compared to those in the upper halves or quartiles.

6.Potato growers and shippers who have their fields and varieties tested and, when possible ship lower peak load fields earlier in the storage season, will have greatly reduced losses due to pressure flattening.

Research Objectives:

- Shrink analysis
- Texture Analysis using CT3 Texture Analyzer at harvest and also after one month of storage
- Pressure bruise analysis: New cultivars will be tested for pile height recommendations.
- New compounds and chemistries will be tested initially on specialty cultivars to minimize water loss in the storage to prevent from pressure bruise

Relationship of proposed research to overall problem for potato growers:
Pressure bruise rated as the most important problem faced by commercial storages in the SLV in the number of grower surveys. Understanding the mechanism of pressure bruise susceptibility will greatly help the industry in reducing the losses.

Timeline and expected short term (1 yr) and long term (3-5 yrs) outcomes:
Lab based and commercial storage studies will help in understanding physiological and genetic basis for pressure bruise susceptibility. This understanding will enable us to devise specific strategies for potato pre and postharvest operations in storages.

Timeline: 2014-2015

Title: Methods to prevent common storage diseases – Prevention and management of silver scurf

Most-relevant funding source: CPAC Area-II

Nature, scope, and objectives of proposed research: Silver scurf is a fungal surface blemish disease of potato (*Solanum tuberosum* L.) tubers, caused by *Helminthosporium solani* Durieu & Mont., which has gained increasing economic importance in recent years. The disease spreads during storage and damages the potato skin. The potato damage expressed in two ways: First the quality of the tubers is decreased. Second, increased weight loss and shrinkage of the potatoes follows the evaporation of water through the damaged skin.

The appearance of silver scurf symptoms is generallylow at harvest. It is under warehouse conditions that the harvested tubers bearing *H. solani* inoculum undergo development and spread of the disease. In particular, conidia can be transported through the air by the ventilation system and serve as a secondary inoculum source, causing the infection of a large number of tubers. Seeding of these infected tubers the following potato growing season carries the inoculum to the field. So far there is no effective control to limit the damage of this disease in the storage.

The discoloration is caused by loss of pigment, through cell desiccation, and suberin deposition. In red skinned potato cultivars, silver scurf can cause a complete loss of skin pigmentation. It does not cause yield losses at harvest, but does cause weight loss of stored potatoes due to increased water loss, resulting in excess shrinkage and flabbiness. Portions of the periderm may eventually slough off. Black spots can be visible due to the presence of *H. solani* conidiophores and conidia on the tuber surface (Stevenson *et al.*, 2001). The disease does not affect any other part of the potato plant except the tubers.

The emergence of silver scurf as a significant disease of potato is due to (i) increased silver scurf incidence (development of thiabendazole-resistant strains, no cultivars with a high level of resistance to silver scurf) and (ii) changes in marketing of potatoes (washed potatoes in clear plastic bags).

Few fungicides are registered for direct application to tubers for control of these important pathogens and few compounds are available for potato tuber treatment in storage, including chlorine-based disinfectants such as, sodium hypochlorite, calcium hypochlorite and chlorine dioxide. Several commercial storage products Phostrol (sodium, potassium and ammonium phosphates), and Storox (hydrogen peroxide/peroaxyacetic acid mixture) are registered for control of storage pathogens. Recently, Stadium a new product from Syngenta Crop Protection was registered for use as a pre-storage treatment for management of Fusarium dry rot and Silver Scurf in storage.

Jet-Ag®, is a peroxyacetic acid (PAA) sanitizer with 4.9% peracetic acid and 26.5% hydrogen peroxide product labeled for agricultural applications. Jet-Ag® labeled uses include; fungicide treatment control or suppression for growing crops in the field and fogging of fruit and vegetable storage systems.

Objectives:

1. Comparing the effectiveness Jet Ag™ and Stadium™ on different cultivars
2. Rates of application and method of application studies

Title: Management of powdery scab

Nature, scope, objectives of proposed research: Powdery scab disease caused by *Spongospora subterranea f. sp. subterranea* is one of the major concerns for potato producers in production regions throughout the world. This is a soil borne pathogen that infects root hairs, stolon epidermal cells, lenticels, eyes and wounds of developing tubers. Infected tubers and roots may have white gall-like growths, which later develop into brown powdery scab tuber lesions as they mature (Harrison et al. 1997).

Powdery scab symptoms cause significant economic losses in both fresh and seed markets. Depending on the severity of symptoms, tubers could become non-marketable or grade quality may be reduced in fresh and seed markets. Seed lots infected with powdery scab may or may not pass inspection depending on the regulations of the certifying agency and the degree of infection. Infected tubers are also more susceptible to secondary infections, such as fusarium dry rot, bacterial soft rot and other pathogens during storage.

Christ (1993) observed that potato cultivars with smooth or light skin (i.e whites and reds) are more susceptible; whereas russet-skinned cultivars are less prone to powdery scab, although root galls are common. There are reports on partial russeting in some cultivars such as Rio Grande Russet. Partial russeting and irregular skin set can lead to disease, loss of water and susceptibility to skin bruise, effecting tuber quality (Lulai EC, 2002). A better understanding of russeting mechanisms will help us to develop new cultural tools for better skin set in new cultivars to enhance the native capacity of tubers for skin set.

We standardized and established a facility to test soil samples to detect and estimate powdery scab spores at postharvest lab. We conducted metabolic studies on how smooth skin cultivars differ from russet skin varieties. We could identify significant differences between them.

The potato genotypes with russet tuber skin are generally resistant to powdery scab. Lipoxygenase and patatin are two key storage proteins that are known to offer resistance to several diseases and insects. The objective of this study was to find out the relationship of these proteins in stored tubers with potato tuber powdery scab resistance, especially in russet skinned potatoes.

The evaluation of potato germplasm with different tuber characteristics for several years in a green house environment suggests that the genotypes with russet skinned tubers (Mesa Russet, Centennial Russet and Russet Nugget) provided resistance to tuber powdery scab with negligible tuber DSI and 100% marketable tubers. Higher physiological levels of LOX protein in the skin region are directly related to powdery scab resistance and tuber russet skin (Figure 1). The total

protein and patatin-lipase levels of tubers did not reveal their role in powdery scab resistance in

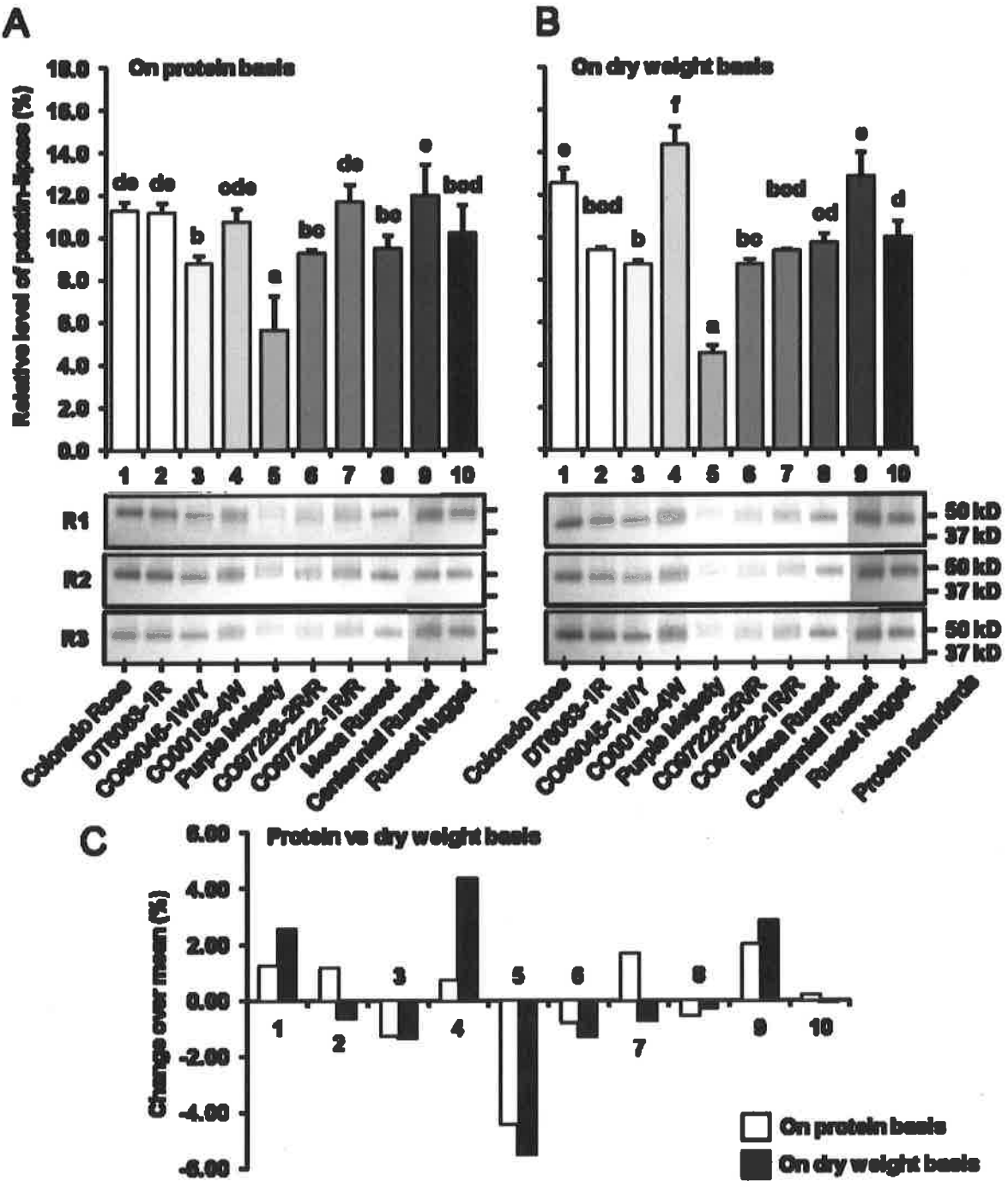

Figure 1: One dimensional SDS-PAGE gels that were stained for lipase activity of patatin in the tubers of various potato genotypes. (A) On protein basis: From each genotype, 5 µg of total tuber protein was used for the SDS-PAGE. (B) On dry weight basis: From each genotype, total protein present in 0.5 mg of tuber dry weight was used for the SDS-PAGE. (C) Changes over mean tuber patatin-lipase value of genotypes were compared between the protein and dry weight basis of analysis. ANOVA was performed on the relative levels of patatin-lipase that were estimated from

3 gels. Mean values that are not significantly different from each other ($P > 0.05$) in each graph are represented by the same letter after the Fisher LSD multiple comparison test. Each bar in a graph represents the mean ± SD of 3 determinations.

these genotypes. Possible resistance mechanisms that were associated with higher physiological levels of LOX protein that include accumulation of phytoalexins, HR mediated cell death and the accumulation of suberin in the periderm of the tubers were discussed here. Physiological levels of LOX protein may be used as a marker for powdery scab resistance in initial screening of stored potato germplasm. Higher levels of LOX segregate with powdery scab resistance may further confirm present findings and the proposed role of LOX in powdery scab resistance in russet skinned potato tubers

Objectives:

1. To find out the relationship of LOX and other cell wall proteins in stored tubers with potato tuber powdery scab resistance, especially in russet skinned potatoes
2. Developing enzyme based marker to screen the germ plasm for resistance to powdery scab disease
3. Developing information on cultivars tolerance to powdery scab spore load in the soils.

Extension-outreach plan for reporting project information to growers (For all proposed projects)

Results will be presented and reported to grower community and scientific community using following avenues.

- Southern Rocky Mountain Ag conference,
- Northern Colorado Potato Grower meeting
- Potato Association of America Annual meeting
- Field days,
- Open house,
- Tours,
- Annual Reports
- Spuditems or newsletter.
- Site visits to commercial storages and
- Web site

Detailed annual budget

Requested funding for 2014-15:	**$48, 500.00**
Research Associate (50%):	$25,000.00
Temporary Labor:	$6,500.00
Equipment and laboratory supplies:	$10,000.00
Chemicals Supplies and Services:	$5,000.00
Travel:	$2,000.00