2006

PROPOSAL TO USDA-ARS COOPERATIVE POTATO RESEARCH PROGRAM
APPLICATION COVER PAGE

Research Plan Title: Managing pressure bruise of potato

Principal Investigator: Sastry S. Jayanty

P.I. Address: 249 East County Road, 9N
San Luis Valley Research Center
Colorado State University
Center CO-81125

P.I. E-mail: sjayanty@lamar.colostate.edu

P.I. Phone: 719-754-3594 ext 11

P.I. Fax: 719-754-2619

Total Funds Requested: $85,866

Project Title: Managing pressure bruise of potato
Principal investigator: Sastry S. Jayanty, Colorado State University
Co-Principal Cooperators: Alvin J. Bussan, University of Wisconsin-Madison, Horticulture
Nora L. Olsen, University of Idaho, Twin Falls

Aim: We are proposing to screen different potato cultivars for their susceptibility to pressure bruise in this multi-regional and institutional collaborative research effort. These varieties will be further characterized at the biochemical, physiological and storage aspects in relation to their susceptibility to bruise.

Summary of Problem: Pressure bruise is a primary concern for all market classes of potato. Pressure bruise limits the storage duration of potato and reduces grade the longer potatoes stored. Pressure bruise can result in quality losses of 20 to 30% in long term storage potatoes, yet little is known about factors influencing pressure bruise. New varieties often times are particularly sensitive to pressure bruise development.
The **Desired Outcomes** include:

Reduce pressure bruise losses in potato storages by 25% within 5 to 10 years
Develop methodology to assess pressure bruise susceptibility prior to storage
Develop tools to predict evolution of pressure bruise based on storage conditions

Pressure bruise is caused by the weight of the pile in storage affecting the structure of tubers on the bottom portion of the bin. Potato pile height is normally limited to 18' to try and minimize the amount of pressure bruise. Turgor pressure is the counteractive force within the cells of potato tubers that prevents the development of pressure bruise. Cells create turgor pressure by increasing water intake into the cell increasing outward force on the cell membranes and walls. Plants regulate turgor pressure during growth by increasing the osmotic potential within cells. Turgor pressure allows cell elongation leading to shoot and root expansion during plant growth. For example, turgor pressure in roots creates a penetration force of up to 1 MPa (145 psi). How that force corresponds to resistance to pressure bruise is unknown. Correspondingly, how turgor pressure or the hydration level or water potential of tuber tissue relates to resistance to pressure bruise is not known either.

During potato crop growth, turgor pressure within tuber tissues are influenced by environmental conditions. For example, as soils become drier the water potential of tuber tissue decreased as transpiration exceeded the rate of water uptake. However, we do not know how well plants or tubers are able to regulate water potential after vine kill or harvest. We do know tubers have little if any ability to absorb water after harvest. Likewise, we know the ability of tubers to resist pressure bruise is dependent on minimal water loss and subsequent effects on cell turgor pressure. Yet little data is available quantifying tuber water relations in storage and how storage management influences water loss from tubers.
Current management practices focus on maximizing tuber hydration prior to harvest and minimizing water loss after harvest. Specific practices include:

- Selecting varieties resistant to pressure bruise
- optimizing tuber growth during the growing season
- irrigation management prior to and after vine desiccation
- managing pulp temperature prior to harvest
- maximizing humidity in storage
- minimizing damage during harvest and sprouting in storage

However, we have little information on how any of these specific practices influence tuber hydration or turgor pressure. Furthermore, we have little information on how tuber respiration or direct moisture evaporation from tuber tissue is influenced by storage management practices. More information is needed quantifying the effects of respiration on tuber water hydration and carbohydrate levels and how that influences susceptibility to pressure bruise and other storage quality attributes such as sugars. In addition, we need more information on direct water loss (evaporation) from tubers and how that is influenced by storage management practices.

Long term goals of this research are to understand physiological processes influencing tuber respiration, turgor pressure, hydration levels, and relationships with shrink and sensitivity to pressure bruise and developing techniques to simulate and predict pressure bruise. This proposal is the first step to understand processes that influence pressure bruise in potatoes.

Research Objectives.

1) Quantify pressure bruise development in several varieties across 3 different U.S. potato production regions
2) Quantify shrink and partition into water and carbohydrate loss for several common varieties
3) Determine influence of different long term storage temperatures on shrink, tuber respiration, and other physiological factors (i.e. sugars).

Research Plan.

Objective 1: Common standard varieties Russet Burbank, Russet Norkotah, Pike, Chipeta, Sangre and Red Norland will be used for trials in CO, WI, and ID. Each state will include 5 to 10 new or soon to be released varieties that local growers have high interest in producing and storing (for example, MegaChip, Villetta Rose, and Gold Rush in WI). Trials will include 3 replications of each potato variety in each treatment at each location. Potato samples will be placed in commercial storages piled approximately 6m high. Commercial bins intended for long term storage (at least 6 mos.) will be utilized instead of research scale bins to insure potatoes are subjected to adequate downward pressure to create bruise. Load sensors will be placed at the same pile height as samples to estimate weight on the potato samples. This data will be used in future trails to configure methods for stimulating pressure bruise. Bins will be managed with current best management practices. Data collection will include weight loss (in and out weight for each sample), pressure bruise (including compression injury and internal tissue damage rating), pulp temperature going into storage, plenum and return air temperature, pile temperature, humidity, and CO2 levels.

Objective 2: Samples of standard varieties (Russet Burbank, Russet Norkotah, Pike, Sangre and Red Norland) will be placed on top of the pile in the commercial storage bin. Samples will consist of 6 tubers. Shrink will be assessed every week for the first 5 weeks of storage, and then every other week over the next 40 week or until the storage is emptied. Shrink will be determined by weighing each sample prior to being placed in storage and after removal from storage. Each variety will require 150 samples to allow for 3 replications and 25 samples. Fresh weight and dry matter content will be measured in each tuber every time shrink is assessed. Data will be used to document shrink, water loss, dry matter loss, and estimate respiration over the course of the storage season. These data will then be correlated to pressure bruise sensitivity of varieties.

Objective 3: Varieties and breeding lines included in objective 1, will be assessed under objective 3. Processing and Chip potatoes will be evaluated at 5, 7, and 9 °C. Fresh market potatoes will be evaluated at 3, 4, and 5 °C Olsen will quantify shrink of varieties under variable temperature regimes at the Kimberly Potato Storage Research Facility in ID. Sucrose and glucose concentrations, fry color and sprouting will be assessed on each variety at Kimberly, ID. Bussan will quantify shrink and respiration of varieties under variable temperature regimes at the Potato and Vegetable Storage Research Facility in Hancock, WI. Respiration will be measured in each potato variety during conditioning at 12 °C and again when potatoes are at the set point 3, 6 and 9 months into storage at Hancock, WI. Jayanty will quantify shrink, sucrose, glucose concentrations and turgor pressure of different varieties under variable temperature regimes at San Luis Valley Research Center in CO. Each sample will include 20 to 40 tubers. Sprouting will be documented in each sample every month.

Budget:

Description	**Jayanty**	**Bussan**	**Olsen**
Research Associate	$18,000 (50%)	$14,166 (41.67%)	$10,000
Fringe Benefits	$3,654 (20.3%)	$4,000 (24%)	$5,750
Lab Supplies/operating expenses	$9,000	$3,000	$8,000
Travel	$1000	$500	$1000
IDC			$7,797 (31.5%)
Total	$31,654	$21,666	$32,546