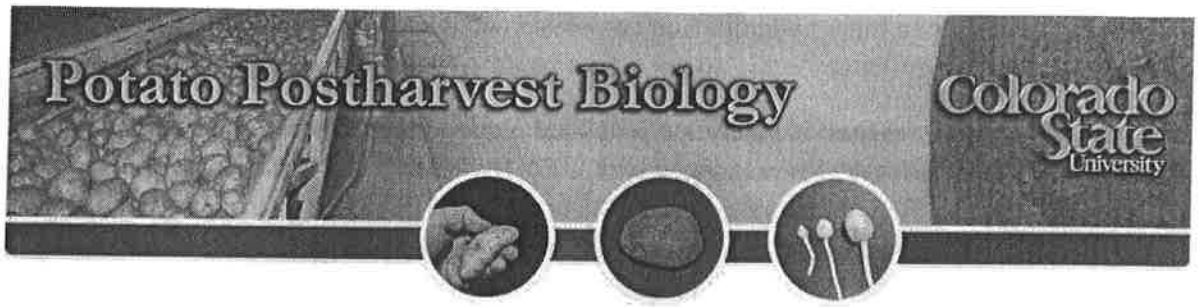

Colorado Potato Administrative Committee, Area II
Proposals for 2015-2016

Sastry S. Jayanty
Potato Postharvest Physiology
San Luis Valley Research Center, Department of Horticulture & LA
www.ppb.colostate.edu

Most-relevant funding source: CPAC-Area II

Postharvest physiology and storage practices

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.

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

The 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 popular russet potato cultivars that are grown in the valley and also specialty cultivars coming out of breeding programs.

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. 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.

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.

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.

2. Title: Reducing the shrinkage in long term potato storage

The nature and scope of proposed Research:

The ventilation system plays a big role in the temperature control and water loss from the tubers in a long term potato storage. The ventilation system is expected to uniformly deliver the desired airflow volume, at the desired temperature and relative humidity (RH) to the potatoes. Ventilation system operation impacts several key environmental parameters that are direct effects of tuber quality and shrinkage. For example, ventilation is required to remove the field heat and respiratory heat of the potatoes as well as eliminate respiratory CO2 accumulation from the storage structure. Airflow requirements are the highest shortly after harvest and typically fall through the winter holding period. In other words, the mass of air flow required during the majority of the storage season may be significantly less than the airflow capability of the ventilation system. Currently storage managers have two choices to avert over-airing, these include reducing the number of hours of fan operation and variable frequency drive fan speed control systems. The physical relationship between fan speed and energy consumption dictates that at reduced fan speeds significant energy savings exist.

The key questions are what is the relationship between tuber moisture loss and air velocity. Do we need to run the fans at low speed constantly later in the season? Or just run high speed fans for a very short period of time?

We are aiming to try both options using very small scale and examine its impact on quail.

Research Objectives:

- Pressure bruise analysis: New cultivars will be tested for pile height recommendations.
- Pressure bruise maintenance guidelines
- Methods to reduce shrinkage in potato storage

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. Shrinkage losses in 2012 were estimated at more than 12 million dollars in Colorado. The potato industry will greatly benefit if we can able to reduce these storage 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: 2015-2016.

3. Title: Reducing the shrink in potato storage

The nature and scope of proposed Research:
The ventilation system plays a big role in the temperature control and water loss from the tubers in a long term potato storage. The ventilation system is expected to uniformly deliver the desired airflow volume, at the desired temperature and relative humidity (RH) to the potatoes. Ventilation system operation impacts several key environmental parameters that are direct effects of tuber quality and shrinkage. For example, ventilation is required to remove the field heat and respiratory heat of the potatoes as well as eliminate respiratory CO2 accumulation from the storage structure. Airflow requirements are the highest shortly after harvest and typically fall through the winter holding period. In other words, the mass of air flow required during the majority of the storage season may be significantly less than the airflow capability of the ventilation system. Currently storage managers have two choices to avert over-airing, these include reducing the number of hours of fan operation and variable frequency drive fan speed control systems. The physical relationship between fan speed and energy consumption dictates that at reduced fan speeds significant energy savings exist.

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

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 generally low 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) sanitized 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

Timeline: 2015-2016.

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
- Variety Release Notes
- Spuditems, Newsletter or Fact Sheet.
- Site visits to commercial storages and
- Web site (ppb.colostate.edu)

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

2015 PROPOSAL FOR COLORADO POTATO ADMINISTRATIVE COMMITTEE, AREA II

TITLE: Evaluate combinations of microbial inoculants that are currently available to San Luis Valley potato farmers for their effects on CRKN management

FUNDING SOURCE: CPAC

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NATURE, SCOPE, AND OBJECTIVES OF PROPOSED RESEARCH:
Columbia Root Knot Nematode (CRKN) is an established pest that causes quality defects in most potato growing areas in the west, including the San Luis Valley of Colorado. The potential for economic damage from CRKN is substantial where pest populations are not kept in check, with consequences ranging from exclusion from premium markets with zero-tolerance standards for infection, to the near total loss of marketable crops from physical tuber damage. Through the use of green manure crops and other biological controls, many farmers in the San Luis Valley have been able to lower the populations of CRKN in their fields, but not often to the point of being able to eliminate chemical controls.

Meloidogyne chitwoodi overwinter in the soil as both second stage juveniles (J2) and eggs that hatch into J2. These J2 invade potato roots and produce large numbers of eggs from which J2 hatch. These J2 invade tubers and cause quality defects or invade the roots again to produce more eggs and J2 that can infect and damage tubers later in the season. Any treatment that reduces early reproduction will reduce the number of J2 present to invade tubers.

Four bio-control products and microbial inoculants were tested in 2014 to assess the potential for reducing CRKN reproduction. Two of the products are direct fungal predators of nematodes. The other two products contain organisms stated to be nematode predators, organisms that provide competition to nematodes, and others that protect roots and improve plant growth. Highly significant results were realized from the 2014 research as each of the products reduced CRKN reproduction significantly over the control. The two biological control products were used at high rates and multiple applications. I-25 was applied at a high and low rate with no significant difference in percent control.

With a shortage of available chemical controls, farmers are looking for best management practices for nematode control using alternative treatments. In 2015, our proposed research would be testing a combination of microbial inoculants that were tested in 2014 as well as testing of reduced rates and with fewer numbers of applications. The desired outcome would be finding optimum rates and timing of applications that would be more cost effective for potato farmers in the SLV.

This project will be a cooperative effort between Oregon State University Nematology Lab and Agro Engineering, Inc. Oregon State University will be responsible for the nematology lab work, the greenhouse trials, and nematode evaluation. Agro Engineering, Inc. will serve as the liason with product suppliers to determine rates and timing for evaluation and will provide reports and present results to farmers.

OBJECTIVES:

1: Evaluate combinations of microbial inoculants that are currently available to San Luis Valley potato farmers for their effects on CRKN management

2: Evaluate MeloCon for its effect on CRKN populations when applied early season to a crop or cover crop and compare CRKN populations to those in untreated controls of each crop.

3: Inform San Luis Valley potato farmers of the utilization of combinations of microbial inoculants to reduce CRKN populations.

JUSTIFICATION, METHODS, PRODEDURES, AND FACILITIES (BY OBJECTIVE)

Objective 1: Evaluate combinations of microbial inoculants that are currently available to San Luis Valley potato farmers for their effects on CRKN management.

Justification: Our research from 2014 showed a substantial reduction of CRKN on wheat plants in pot trials after applications of both *Paecilomyces lilacinus* and microbial inoculants. Other studies have shown infection of both eggs and mobile stages of nematodes by *Paecilomyces lilacinus*. Growers were provided with a list of products that are potential alternatives to chemical controls, allowing farmers to make an informed choice as to the relative effect the products may have on CRKN populations.

Procedures: Products evaluated in 2014

Company	Product	CO Label	% reduction over control
Certis USA	MeloCon - Paecilomyces lilacinus	YES	92%
Soil Guys	Bio Blend	YES	64%
Holmes Enviro	Hyper Galaxy	YES	68%
Innovak Global	I-25 (2 rates)	NO	86%

Procedures: Products proposed for evaluation in 2015

Company	Product	CO Label	2014 testing
Certis USA	MeloCon - Paecilomyces lilacinus	YES	92% reduction
Soil Guys	Bio Blend	YES	64% reduction
Holmes Enviro	Hyper Galaxy	YES	68% reduction
Innovak Global	BioFit N	YES	Completely different product

Products will be evaluated alone and in combination to determine whether CRKN management can be enhanced with a combination of products. There will be five pots per treatment.

Product	Rate	Combination	At plant	30-35 DAP	800 GDD (60 DAP)
MeloConWG	2#/a	none	X		
MeloConWG	4#/a	none	X		
MeloConWG	6#/a	none	X		
Bio Blend	10gal/a	none	X	X	X
Hyper Galaxy	4oz/a	none	X	X	X
BioFit N	1#/a	none	X	X	X
Bio Blend	10gal/a	MeloConWG @4#/a AP	X	X	X
Hyper Galaxy	4oz/a	MeloConWG @4#/a AP	X	X	X
BioFit N	1#/a	MeloConWG @4#/a AP	X	X	X

Greenhouse Pot Trials – There will be five pots per treatment placed in a randomized block design. Moist sandy loam potting soil will be added to fill each gallon pot. To simulate at-plant in-furrow treatments, soil will be emptied from each pot into a dishpan. 5000 eggs of *M. chitwoodi* will be gently mixed into the soil, product will be applied and mixed into the soil, and soil will be returned to the pot. All pots will be planted with a three-week-old Stephens wheat seedling, an excellent CRKN host. Additional post plant applications will be made according to the chart by applying products in water to simulate ½ inch irrigation.. Plants will be harvested at 12 weeks. Plant and soil will be removed from the pot into a dishpan. Plants will be removed from soil, which will be mixed and weighed and 250 g sample removed for extraction of J2. Soil will be gently washed from roots and eggs extracted from them. Data to be collected will be total eggs per plant, total J2 per pot, and reproduction factor. (Reproduction Factor = (Total eggs + Total J2)/ Initial eggs added.)

Objective 2: Evaluate MeloCon for its effect on CRKN populations when applied early season to a crop or cover crop and compare CRKN populations to those in untreated controls of each crop.

Justification: *Paecilomyces lilacinus* has been shown in scientific studies to reduce the number of nematode eggs in the soil and to have additional effects on J2 nematodes. MeloCon is the only *Paecilomyces lilacinus* product currently labeled in Colorado. This study will test application of MeloCon to host and non-host crops for CRKN to see whether nematode reduction can be

achieved with application to a living plant soon after planting the crop. This information would assist farmers in deciding whether an in-season application of *Paecilomyces lilacinus* to a rotational crop would be a useful investment towards reducing CRKN populations and associated risk preceding potatoes.

Procedures:

Crop	Treatment	Rate
C-69 Barley	None	
Sordan 79	None	
Oilseed radish	None	
C-69 Barley	MeloConWG	2#/a
Sordan 79	MeloConWG	2#/a
Oilseed radish	MeloConWG	2#/a

Greenhouse Pot Trials – There will be five pots per treatment placed in a randomized block design. Moist sandy loam potting soil will be added to fill each gallon pot; 10 pots will be planted to C-69 barley, 10 pots will be planted to Sordan 79 sorghum sudangrass, and 10 pots will be planted to oilseed radish (cultivar TBD). 5000 eggs of *M. chitwoodi* will be added to each pot after plants have reached 3" in height. MeloCon will be added to 5 pots of each crop at the 2 lb. /acre rate in a simulated irrigation event. Plants will be harvested at 70 days. At harvest, plant and soil will be removed from the pot into a dishpan and a 250 g sample removed for extraction of J2. Soil will be gently washed from roots and eggs extracted from them. Data to be collected are total eggs per plant, total J2 per pot, and reproduction factor. (Reproduction factor = (Total eggs + Total J2)/ Initial eggs added.)

As an additional evaluation a three-week-old seedling of Stephens wheat will be planted into soil from each pot to evaluate the level of residual activity of the MeloCon. Plants will be harvested at 60 days and evaluated as described above.

Objective 3: Inform San Luis Valley potato farmers of the utilization of combinations of microbial inoculants to reduce CRKN populations.

Justification: Relating the findings of this study to potato farmers of the San Luis Valley will allow for improved decision making regarding selection and use of bio-control products for control of CRKN and improving the yield and quality of their potato crop.

Procedures: Statistical analysis on data collected from pot trials and field trials in Objectives 1 and 2 will be performed and findings from the study summarized into reports and presented to CPAC and San Luis Valley farmers. Relating the findings of this study to potato farmers of the San Luis Valley will allow for improved decision making regarding biological nematode control products and their use. This information will be made available to CPAC during the winter following the study period, in time to inform farm plans for the following planting season.

ENHANCEMENT OF COMPETITIVENESS OF COLORADO POTATO GROWERS

Development of reduced cost and reduced pesticide-intensive measures for nematode control are required to maintain Colorado's competitive advantage relative to other potato growing regions. Research in pest management to reduce CRKN populations while allowing maximum economic return to farms, is critical for the long-term viability of the state's potato producers. Our research in 2014 provided farmers much needed information on these microbial inoculants. Information gained from the 2015 proposed research will increase the options Colorado potato farmers have for making informed decisions to minimize risk, maximize economic returns, build soil health, and reduce the reliance on chemical nematicides and fumigants.

EXTENSION-OUTREACH PLAN

The cooperating investigators will work together to form recommendations for the most effective and economical use of biological nematode control relative to CRKN and the resource and investment required. Findings from this study will be communicated to potato growers in early 2016. These results and recommendations will be made available to CPAC for communication to its membership electronically.

POTENTIAL OF PROPOSED RESEARCH TO OBTAIN FURTHER FUNDING

There is potential for additional funding from both Innovak Global and Certis USA.

TIMELINE AND OUTCOMES

All greenhouse trials and tuber analysis for CRKN damage will be completed by December 2015.

BUDGET AND JUSTIFICATION

	Rate		Expense Category		Expense Amount		Total
	per pot	Flat rate	Lab fees	Labor	Lab fees	Labor	
Objective 1 10 treatments * 5reps	$154.42	$7,721	100%		$7,721		$7,721
					Objective 1 total		$7,721
Objective 2 6 treatments * 5 reps Original Test Bioassay	 $176.41 $135.47	 $5,292 $4,064	 100% 100%	 	 $5,292 $4,064	 	 $5,292 $4,064
					Objective 2 total		$9,356
Objective 3 Data analysis Report & Communicate findings		$2,200		100%		$2,200	$2,200
					Objective 3 total		$2,200
			Category totals		$17,077	$2,200	$19,277
			Percent of budget		89%	11%	100%
			Expense category		Lab fees	Labor	
			Total		$17,077	$2,700	$19,277