MANAGEMENT OF COLORADO POTATO FOR SUSTAINABLE TUBER YIELD AND QUALITY

SUMMARY OF RESEARCH PROGRESS REPORT FOR 2011 AND RESEARCH PROPOSAL FOR 2012

SUMITTED TO:

COLORADO POTATO ADMINISTRATIVE COMMITTEE (CPAC) - AREA II

SUBMITTED BY

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SUMMARY OF 2011 RESEARCH STUDIES

Each potato cultivar has its own unique set of cultural management requirements to attain maximum tuber yield and quality. To attain the sustainable yield and quality potential of any potato cultivar, optimum management guidelines for the cultivar need to be followed. The objective of this project was to establish cultivar specific management guidelines for the successful, sustainable, and economic production of new and existing potato cultivars, which optimize their genetic potential, while minimizing economic inputs and environmental degradation. In 2011, horticultural evaluations were conducted on 28 potato cultivars and advanced selections in 21 trials at 11 locations in the San Luis Valley of Colorado. Tests included 16 Russets, 10 Specialty Potatoes, four chipping potatoes, and 1 fingerling. The trials assessed the influence of different cultural management practices on plant growth, development, tuber yield, tuber size distribution, and tuber quality of potato cultivars, in an effort to establish optimum management guidelines for each cultivar. Studies conducted in 2011 included the response of six potato cultivars to different nitrogen (N) application rates. Nitrogen rate treatments ranged from 0 (control) to 180 lb N/A. The influence of in-row seed spacing on the performance of five potato cultivars was evaluated. Potato cultivars were planted at 10, 12, and 14 inches. The effect of late N application on the performance of four Russet potatoes was evaluated. Late N application treatment rates included 20 and 40 lb inorganic N/A, 20 and 40 lb organic N/A, and a control where no late N was applied. All data collected were summarized into a booklet and distributed to potato growers during the Southern Rocky Mountain Agricultural Conference and Trade Fair. Observations from the 2011 field studies and some of the data collected were presented at the Potato Research and Extension program meeting held in Minneapolis, MN; at the Southern Rocky Mountain Agricultural Conference in Monte Vista, CO; to crop consultants in the San Luis Valley, CO; at various professional meetings in the United States, and at the Potato Expo, to potato industry personnel. A field day was organized for potato growers at the San Luis Valley Research Center, Colorado, to allow stake holders to see how the potato crop performed under different management treatments, and to foster discussion with, and among members of the research committee of the Colorado Potato Administrative Committee. Some of the results from the 2011 studies were discussed with potato growers during the potato cultivar evaluation committee meeting, to help take decisions on advanced selections that need to be named, or need further research studies, or those that need to be discarded from research programs. Grower cooperators were given a tour of the advanced selections planted in their fields. Some results of the 2011 studies were published in potato grower magazines such as, in the Potato Grower and the Spudman magazines. Some of the results were also submitted for publication in a peer reviewed journal, and as a book chapter.

Cultivar specific management guidelines were developed for some new cultivars.

Some Cultivar Specific Management Guidelines Developed from the 2011 Research Studies

CO99053-3RU Management Guidelines

In-Row Seed Spacing: 12-12.5 inches, with row spacing of 34 inches.

Nitrogen Requirement:

Available N Rate (Soil N + Irrigation Water N + Applied N fertilizer):
160-170 lb N/A
Pre-plant Available N: 50-60% of total available N

Finish applying the rest at least 30 days before vine kill. This will allow for tuber skin maturation.
Late N application delays skin maturation
Harvest 18-21 days after vine kill for good skin set.

Petiole Nitrate Levels:

11,000 ppm-12,000 ppm at tuber initiation
Reduce to 10,000 ppm-11,000 ppm midseason
7,000 ppm-8,000 ppm late season

C099100-1RU Management Guidelines

In-Row Seed Spacing: 12-13 inches, with row spacing of 34 inches.

Crop Maturity: This is an early Russet cultivar. It can be harvested 90-100 days after planting.

Vine Desiccation: Do not vine kill. Allow plants to grow until vines are dead. This will allow for full tuber maturity and skin set.

Nitrogen Requirement:

Available N Rate – 140-150 lb N/A
Pre-Plant Available N: 60-70% of total available N
Finish applying the rest early in the season
Any late application of N will delay skin set

2012 RESEARCH PROPOSAL

Project Title

Development of cultivar specific management guidelines for new potato cultivars

Funding Source

Colorado Potato Administrative Committee (CPAC), Area II

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Nature and Scope of Proposed Research

The development of cultivar specific management guidelines for new potato cultivars aims at tailoring cultural management guidelines to individual potato cultivars. Management guidelines consist of cultivar specific management information pertinent to production such as fertility management, irrigation/water management, plant population management (in-row seed spacing), reducing the risk of pesticide use without compromising tuber yield and quality, and vine kill and harvest date management for improved tuber skin set.

The proposed research for 2012 will evaluate the response of new potato cultivars to several cultural management practices, including fertility management, with emphasis on nitrogen (N) use efficiency, and plant population (in-row seed spacing) management.

The performance of several advanced potato selections grown under different management practices and in different soil types will be evaluated in several grower fields.

Objectives of Proposed Research

The general objectives of this proposal are to develop cultural management guidelines for the successful, sustainable, and economic production of potato cultivars grown in the San Luis Valley, which optimize their genetic potential while minimizing environmental degradation. The management strategies should be agronomically sound, economically advantageous, and environmentally responsible.

The specific objectives of this research proposal are;

1. Define optimum nitrogen application rates for the efficient use of nitrogen by new potato cultivars, which will lead to maximum tuber yield, tuber size, and production of quality tubers.

2. Define optimum petiole nitrate-nitrogen concentration levels for new potato cultivars that will aid in efficient in-season nitrogen management.

3. Define optimum in-row seed spacing for the production of maximum tuber yield, tuber size, and quality of potato cultivars grown in the San Luis Valley.

4. Evaluate the yield and quality response of several advanced potato selections from the Colorado Potato Breeding Program to different management practices under grower conditions.

MATERIALS AND METHODS

Objective 1 **Define optimum nitrogen application rates for the efficient use of nitrogen by new potato cultivars, which will lead to maximum tuber yield, tuber size, and production of quality tubers.**

Nitrogen (N) fertilizer requirement for production of maximum tuber yield, tuber size, and quality tubers, differ among potato cultivars. In irrigated potato cropping systems, the crop preceding potatoes, soil residual nitrogen, and irrigation water nitrogen, all influence the amount of nitrogen needed to be applied to obtain maximum yield and quality tubers. There is the need to establish available N (applied, plus soil, plus irrigation water N) fertilizer required for the efficient use of N by new potato cultivars that are currently being grown, and those that have the potential of being grown in the San Luis Valley. The response of individual cultivars to N rate will be plotted, and regression lines will be developed for each cultivar to determine the optimum N rate that will yield maximum tubers of premium size and quality. Treatments will be replicated four times in a randomized complete block design.

Objective 2 **Define optimum petiole nitrate-nitrogen concentration levels for new potato cultivars during the growing season that will aid in efficient in-season nitrogen management.**

While the total nitrogen applied can significantly influence tuber yield, tuber size, and quality of potato tubers, in-season nitrogen fertilizer management can also influence the efficient use of applied N, and can influence tuber yield, tuber size, and quality. Developing optimum petiole nitrate-nitrogen levels for new potato cultivars can aid growers in the proper management of in-season nitrogen application.

In-season nitrogen application will begin one week after tuber formation, and will continue at weekly intervals until the required N rate is applied (normally between the second and third week of July). Petiole samples will be taken from all experimental plots at weekly intervals until one week after final nitrogen fertilizer application. Petiole samples collected will be oven dried, ground, and analyzed for petiole nitrate-nitrogen concentration as well as the concentration of other nutrients in the petiole.

Objective 3 **Define optimum in-row seed spacing that will maximize tuber yield, tuber size, and quality of new potato cultivars grown in the San Luis Valley**

In-row seed spacing is one of the production factors under grower control, which can be used to manipulate tuber size and yield. Different markets require different tuber size. It is therefore important that we evaluate the optimum in-row seed spacing needed for maximum tuber yield and production of premium size tubers. Studies will be conducted to evaluate the response of tuber yield, tuber size, and quality to in-row seed spacing.

Objective 4 **Evaluate the yield and quality performance of several advanced potato selections from the Colorado Potato Breeding Program when grown under different management practices in grower fields.**

The objective of this study is to evaluate tuber yield, tuber yield stability, and quality performance of advanced selections from the Colorado Potato Breeding Program when grown under different management practices and in different soil types. Several advanced selections of Russets, Reds, Specialty type potatoes, and fingerlings, will be planted in strips on grower farms. The farms that will be selected will differ in crop management practices and in soil type. Clones entered in this study will be evaluated for maturity date. At harvest, each clone will be evaluated for yield and tuber quality. This study will help in the identification of early maturing cultivars and how they respond to different management practices.

Data Collection

Soil and Water Samples

Soil samples from experimental plots and water samples from the irrigation well will be taken in the spring and analyzed for their nutrient content. This will indicate the amount of residual nitrogen and other nutrients in the soil before planting, and how much nitrate nitrogen is supplied to the crop from the irrigation water at each time of irrigation. Soil samples will also be taken at the end of the crop harvest and analyzed for the nutrients that were not used by the crop. This will help evaluate for nutrient use efficiency.

In-Season Plant Sampling and Measurements

The effect of treatments on sprout emergence, crop stand, green leaf production, and canopy development will be evaluated. During tuber bulking, plants will be sampled

to evaluate treatment effects on stem number, tuber number, mean tuber weight, and tuber bulking rate.

Tuber Yield and Quality Evaluation

Potato tubers will be harvested and evaluated at the end of the growing season for yield and tuber size distribution. Tubers from each plot will be weighed and graded for external (misshapes, knobs, growth cracks) and internal (hollow heart and brown center) defects. The harvested tubers will be separated into various size distribution groups based on weight (<4 oz, 4-6 oz, 6-8 oz, 8-10 oz, 10-12 oz, 12-16 oz, and >16 oz), and diameter [<2 inches (in.), 2-4 in., >4 in., >2 in. but <10 oz, >2 in. and >10 oz], to evaluate treatment effects on tuber size profile for each cultivar. Ten large (10-16 0z) tubers from each plot will be taken for hollow heart and brown center evaluation. Specific gravity will be measured using the weight-in-air/weight-in-water method.

Statistical Analysis

All data will be subjected to analysis of variance to test for main effects and interactions among cultivars and treatments where appropriate. When significant interaction effects are detected, the proc mixed procedure in SAS will be used to analyze the data to estimate differences between treatment means. Some treatment means will be separated using contrast.

How the Project Will Enhance the Competitiveness of Colorado Potato Growers

Each potato cultivar has its own unique set of cultural management requirements for the production of maximum tuber yield, tuber size, and high quality tubers. More often than not, growers of a new cultivar are not able to obtain the yield and quality potential of the cultivar because they do not have information on the specific management requirements for that cultivar. Growers of a new cultivar are more successful when release is accompanied by appropriate management guidelines. The best cultural management guidelines are obtained from field experiments conducted in replicated trials in specific production regions. Also, in the cultivar evaluation and development process, shortcomings of advanced selections and new cultivars may be identified and appropriate cultural management strategies are explored to solve such cultivar specific problems. Cultivar specific management guidelines developed from this research project will result in the successful production of new and existing potato cultivars grown in the San Luis Valley.

Extension-Outreach Plan for Reporting Project Information to Growers

Data from this project will be presented at the Southern Rocky Mountain Agricultural conference and Trade Fair.
Extension fact sheets will be developed for each potato cultivar entered in this project to highlight management guidelines for each cultivar.
Results from this project will be posted on the CPAC website, as well as on the San Luis Valley Research Center website.
Summary of data from the project will be printed and hard copies distributed to potato growers in the San Luis Valley.

Potential for Results to Leverage Additional Outside Funding

This project will provide preliminary data for the submission of proposals to agencies such as USDA - NIFA as part of the potato development and improvement project, and to USDA-NRCS and Western SARE for nutrient use efficiency research. Funding from the Environmental Protection Agency (EPA) could help in research involving reduction in fertilizer use, and sustainable potato production. Other sources of funding could be from fertilizer companies, and compost dealers for nutrient management studies.

Timeline of Proposed Research and Expected Short Term (1 yr) and longer Term (3-5 yrs) Outcomes

Potato seed will be cut and cured in April. All potato seed will be planted between May 1 and May 20, 2012. In-season nitrogen application will be completed in July. Petiole samples will be collected in July. Sampling for tuber bulking will start in mid-July and end in mid-August. Potato vines will be killed in August, and tubers harvested in late September.
Tuber sizing and grading will be done in October and November.
Statistical analysis and report writing will be done in December and January. Results will be posted on the website in February, and printed data distributed to growers at the same time.
At the end of the 2012 growing season, cultural management guidelines will be updated for some of the currently cultivated russet and specialty potato cultivars. Preliminary information on management guidelines for some new and advanced russet potatoes will be documented at the end of the 2012 growing season. Cultural management guidelines will be completed for some cultivars at the end of the 2012 growing season. Potato cultivars that will be released between 2013 and 2016 will be accompanied by management guidelines for the successful production of those cultivars.

ANNUAL BUDGET

Personnel

Three non-student help will be needed to get the field and laboratory studies completed successfully.

Three persons working for 32 weeks (3840 hours) @ $8.5/hr =	$32,640.00
Fringe Benefits for personnel =	$ 2,360.00
Total Wages and Fringe Benefits for Personnel	**$35,000.00**

Materials and Supplies

Potato sacks, gloves, masks, sample paper bags, field stakes, flags, and scissors	$2,000.00
Fertilizer purchase	$2,000.00
Total Materials and Supplies	**$4,000.00**

Services

Soil and water analysis	$ 400.00
Petiole sample analysis: 100 Samples per sample date x 4 sample dates x $19.00/sample	$7,600.00
Total Services	**$8,000.00**
Travel	**$2,000.00**
Total amount of this request	**$49,000.00**

Budget justification

Salaries and Wages for Personnel:

Because of the extensive field and lab work involved in the studies proposed, including soil sampling, seed cutting, potato planting, in-season data collection (whole plant sampling, petiole sampling), extensive fertilizer application before and during the growing season, potato harvest, sizing and grading, data compilation and analysis,

considerable financial resources are committed to personnel. Thirty five thousand dollars ($35,000.00) is requested for wages and fringe benefits in this budget.

Materials and Supplies:

Field supplies include items such as field stakes, flags, sample paper bags, gloves, masks, scissors, and potato sacks for harvesting. Fertilizer will be purchased. Four thousand dollars ($4,000.00) is requested for materials and supplies in this budget.

Services:

Soil samples will be taken from each experimental plot before planting and from each fertility management plot after harvest. Petiole samples will be taken at four different dates during the crop growing season. Water samples will also be taken from the irrigation well. All samples collected will be sent to a soil, water, and plant nutrient analytical lab for analysis. Eight thousand dollars ($8,000.00) is being requested for payment of sample analysis.

Travel

Two thousand dollars ($2,000.00) is being requested for part payment of travel expenses to potato evaluation and development meetings, as well as potato cultivar management meetings.