

**MANAGEMENT OF COLORADO POTATO FOR
SUSTAINABLE TUBER YIELD, TUBER QUALITY, AND
ECONOMIC IMPLICATIONS**

**SUMMARY OF RESEARCH PROGRESS REPORT FOR 2012
AND RESEARCH PROPOSAL FOR 2013**

SUMMITTED TO:

**COLORADO POTATO ADMINISTRATIVE COMMITTEE
(CPAC) - AREA II**

SUBMITTED BY

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SUMMARY OF 2012 RESEARCH STUDIES

Each potato cultivar has its own unique set of cultural management requirements to attain maximum tuber yield and quality. To attain sustainable yield and quality potential of any potato cultivar, optimum management guidelines for the cultivar need to be followed. The objective of the 2012 research studies 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 2012, horticultural evaluations were conducted on 25 potato cultivars and advanced selections in 16 trials at 9 locations in the San Luis Valley of Colorado. Tests included 13 Russets, 10 yellow flesh specialty potatoes, and 2 Reds. The trials assessed the influence of different cultural management practices on plant growth, development, tuber yield, tuber size distribution, and tuber quality of the cultivars studied, in an effort to establish optimum management guidelines for each cultivar. Studies conducted in 2012 included the response of four potato cultivars to different nitrogen (N) application rates. Nitrogen rate treatments ranged from 0 (control) to 240 lb N/ha. The effect of N rate treatments on mid-season petiole nitrate nitrogen concentration was evaluated. The effect of extra late N application on the performance of four Russet potato cultivars was evaluated. Late N application treatments included 20 and 40 lb inorganic and organic N/ac, and a control where no extra late N was applied. The effect of soil amendments on potato root development, nutrient uptake, tuber yield and quality was evaluated. The response of russet potato to the form and rate of potassium (K) fertilizer application was studied in 2012. The influence of ten preceding green manure cover crops on russet potato performance was evaluated. Seventeen advanced selections from the CSU potato breeding program were evaluated under six potato grower management conditions in order to determine the yield stability as well as the optimum management conditions suitable for each cultivar to attain its yield and quality potential. Observations from the 2012 field studies and some of the data collected were presented at the Southern Rocky Mountain Agricultural Conference in Monte Vista, CO; to potato growers in northern Colorado; and at various professional meetings in the United States. A field tour was organized for some of the potato growers at the San Luis Valley Research Center, Colorado; for some potato consultants; participants of the college of Agricultural Sciences Tour, from Colorado State University, to allow stake holders to see how different potato cultivars perform under different management treatments, and to foster discussion with and among members of the research committee from the Colorado Potato Administrative Committee. Some of the results were published in the Spud Item (a monthly publication by CPAC to potato growers), potato grower magazines such as the Spudman magazine, and the Potato Grower magazine. Some of the results were also published as book chapter and in peer reviewed journal. Cultivar specific management guidelines were developed for some new cultivars.

Some Cultivar Specific Management Guidelines Developed at the end of the 2012 Research Studies

Field Management of CO99100-1RU

CO99100-1RU is an early Russet variety. Pre-cut seed to a size of 2.5 to 3.0 oz. and allow seed to suberize before planting.

To obtain maximum marketable size tubers, seed tubers should be planted at in-row spacing of 12 to 13 inches, with between row spacing of 34 inches.

Available nitrogen (N) (residual soil N + irrigation water N + applied N) rate required for optimum tuber yield and quality should be between 140 to 150 lb N/A. This recommendation does not include nitrate nitrogen mineralization from previous crop stubble and from soil organic matter.

To gain early plant vigor, apply about 30% of the required seasonal N pre-plant or at planting. Apply the remaining N rate requirement in three equal split applications at approximately 7 to 10 days intervals during the growing season.

Begin in-season N application after tuber initiation. Finishing N application early in the season is recommended.

Optimum petiole nitrate concentration should range between 5,000 to 6,000 ppm at tuber initiation; 2,000 to 5,000 ppm at tuber bulking; and below 2,000 ppm at tuber maturity. Do not plan on vine kill. The vines of CO99100-1RU will die naturally when tubers are mature.

A total of 15 inches of irrigation water throughout the growing season is sufficient, while maintaining soil water content above 65 to 70%.

Tubers can be harvested between 90 to 100 days after planting.

Field Management of Mesa Russet

Pre-cut seed to a size of 2.5 to 3.0 oz. and allow to suberize before planting.

To obtain maximum marketable size tubers, seed tubers should be planted at in-row spacing of 13 to 14 inches, with between row spacing of 34 inches.

Available nitrogen (N) (residual soil N + well water N + applied N) rate required for optimum tuber yield and quality should be between 145 to 150 lb N/A. This recommendation does not include nitrate nitrogen mineralization from previous crop stubble and from soil organic matter.

To gain early plant vigor, apply 85 to 90 lb available N/A (residual soil N + well water N + applied N) pre-plant or at planting.

Apply the remaining N rate requirement (60 lb N/A) in three equal split applications at approximately seven days interval during the growing season. Begin in-season application after tuber formation. End in-season N application by the end of July in the San Luis Valley. Finishing N application earlier in the season is preferred.

Petiole nitrate N concentration should range from 17,000 ppm at about 57 days after planting (DAP), down to 10,000 ppm at 78 DAP.

Vines should be killed at approximately 115 DAP to allow tubers to mature and to avoid tuber bruising at harvest.

2013 RESEARCH PROPOSAL

Project Title

Development of cultivar specific management guidelines for Colorado potato cultivars

Funding Source

Colorado Potato Administrative Committee (CPAC), Area II

Investigator

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Department of Horticulture and Landscape Architecture
San Luis Valley Research Center

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 2013 will evaluate the response of Colorado 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 six 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 fertilizer application rates for the efficient use of nitrogen by Colorado potato cultivars, which will lead to maximum tuber yield, tuber size, and production of quality tubers.
2. Define optimum in-season petiole nitrate-nitrogen concentration levels for Colorado potato cultivars that will aid in efficient nitrogen fertilizer management.
3. Evaluate the proper timing of nitrogen fertilizer application for efficient nitrogen use that will optimize tuber yield and quality of Colorado potatoes.
4. 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.
5. Evaluate the yield and quality response of several advanced potato selections from the Colorado Potato Breeding Program to different management practices under grower conditions.
6. Evaluate the economic implications of different management guidelines that maximize net returns of potato growers.

MATERIALS AND METHODS

Objective 1 Define optimum nitrogen application rates for the efficient use of nitrogen by Colorado 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 Colorado 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 graphed, 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 in-season petiole nitrate-nitrogen concentration levels for Colorado potato cultivars that will aid in efficient nitrogen fertilizer 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 distribution, and quality. Developing optimum petiole nitrate-nitrogen concentration levels for Colorado 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 application of the required N rate is completed (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 the final nitrogen fertilizer application is done. 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 Evaluate the proper timing of nitrogen fertilizer application for efficient nitrogen use that will optimize tuber yield and quality of Colorado potatoes.

While the total nitrogen applied can influence tuber yield, size, and quality of potato cultivars, the appropriate timing of the nitrogen applied can significantly influence how efficient the applied nitrogen is used to maximize tuber yield, tuber size, and quality. A study will be conducted to evaluate the effect of early, mid, and late application of N on the performance of potato cultivars grown in the San Luis Valley. Treatments will include (i) the application of 2/3 of the required nitrogen pre-plant, and the remaining 1/3 applied during the growing season (ii) application of half of the required nitrogen pre-plant and the remaining half during the growing season (iii) application of 1/3 of the required nitrogen pre-plant, and the remaining 2/3 of the required nitrogen applied during the growing season. A control treatment will be included where no nitrogen will be applied pre-plant, but all the required nitrogen will be applied during the growing season. The effect of the nitrogen application timing treatments on nitrogen use efficiency, tuber yield, tuber size distribution, and quality of different potato cultivars will be evaluated.

Objective 4 Define optimum in-row seed spacing that will maximize tuber yield, tuber size, and quality of 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 5 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.

Objective 6 Evaluate the economic implications of different management guidelines that maximize the net returns of potato growers.

Economic analysis will be performed for the different management guidelines evaluated for Colorado potato cultivars, using the principle of net returns. The optimum economic management guideline will be evaluated for recommendation to potato growers.

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 set, mean tuber weight, and tuber bulking rate.

Petiole samples will be taken at four different dates during the growing season for petiole nutrient analysis. This will help establish in-season petiole nitrate, phosphorous, and potassium curves for individual cultivars.

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 Oz) 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 the *a priori* single degree of freedom 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 Colorado 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.
Management guidelines for specific cultivars will be documented in the spud items for quick release to potato growers.
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, 2013. In-season nitrogen application will be completed in July. Petiole samples will be collected in July. Sampling for tuber bulking will be done in 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 2013 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 2013 growing season. Cultural management guidelines will be completed for some cultivars at the end of the 2013 growing season. Potato cultivars that will be released between 2014 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.

