SUMMARY RESEARCH PROGRESS REPORT FOR 1998
AND RESEARCH PROPOSAL FOR 1999

Submitted to:

SLV Research Center Committee
and the
Colorado Potato Administrative Committee (Area II)

TITLE: Potato Breeding and Selection

PROJECT LEADER: David G. Holm

PROJECT JUSTIFICATION: Many challenges and opportunities are confronting the Colorado potato industry. These challenges/opportunities include food safety, water quality, current market constraints, new market development (processing, exporting, etc.), changing consumer expectations, and increasing costs with highly variable potato prices.

To help meet each of these challenges, continued emphasis needs to be placed on developing potato cultivars with increased yield, improved quality, resistance to diseases and pests, and tolerance to environmental stresses. Increased emphasis needs to be placed on breeding for improved postharvest and processing qualities such as lengthened dormancy, ability to process after cold storage, and resistance to diseases such as tuber early blight and late blight. Cultivars with these characteristics will help assure that the potato industry in Colorado will remain productive and in a competitive position.

PROJECT STATUS: This is an ongoing project.

SIGNIFICANT ACCOMPLISHMENTS FOR 1998:

Fifty-five parental clones were intercrossed in 1998. Seeds from 375 combinations were obtained. Primary emphasis of this crossing block was on fresh and processing russets, chippers, and reds. Seedlings from selected families will be produced in 1999 for initial field selection in 2000.

One hundred twenty 1997 seedling families were grown in the greenhouse producing 50,926 seedling tubers for initial field selection in 1999. Second thru forth size will be distributed to Idaho, Minnesota, Oregon, Texas, and Alberta, Canada.

A second, smaller planting of seedlings representing 50 families consisting of 10,848 plants was grown in the greenhouse. These families resulted from 1997 crosses emphasizing specialty types and will also be planted in 199 for initial field selection.

A total of 74,517 first-year seedlings were planted with 826 being selected at harvest for further observation. Another 1,048 clones were in 12-hill, preliminary, and intermediate stages of selection. Of these, 270 were saved at harvest for further evaluation. Thirty advanced selections were saved and contingent on additional evaluations, will be increased in 1999. Another 181 selections were maintained for germplasm development, breeding, other experimental purposes, or seed increases for the Texas program.

Grower evaluations were conducted on seven russets (AC83064-1, AC83064-6, AC87084-3, AC88042-1, AC88165-1, CO80011-5, and CO85026-4), one chipping selection (BC0894-2), and two reds (CO86218-2 and DT6063-1R). Selections AC88042-1 and AC88165-1 were discarded based on overall performance in 1998. The balance of these selections will undergo continued grower evaluation.

The following selections are to be named in 1999: AC83064-1 (Keystone Russet), AC83064-6 (Silverton Russet), and DT6063-1R (Cherry Red). Plant Variety Protection was applied for on Russet Norkotah Selections 3 and 8.

Five new selections, including three new russets (AC87079-3, AC87138-4, and CO89036-10), one chipper (AC87340-2), and one red (CO89037-7) will be evaluated by growers in 1999.

A total of 156 samples were evaluated for two or more of the following postharvest characteristics: blackspot susceptibility, storage weight loss, dormancy, enzymatic browning, specific gravity, chip color, french fry color, and french fry texture.

OBJECTIVES FOR 1999:

1. The potato breeding and selection program will be continued. Advanced clones will be tested, as appropriate in yield trials, Western Regional Trials, out-of-state trials, and by growers.

2. Twelve-hill plots will be screened for potato spindle tuber viroid (PSTV).

3. Test intermediate and advanced selections from the breeding project and Western Regional Trials for: blackspot susceptibility, storage weight loss, dormancy, enzymatic browning, specific gravity, chip color, french fry color, and french fry texture. *Protocols will be developed to determine tuber susceptibility to greening and sugar content (sucrose and glucose) of advanced selections. Advanced red selections will also be characterized for skin color retention during storage.*

4. Continued emphasis will be placed on identifying parental material for developing germplasm with dry rot (Fusarium and early blight), late blight, and bacterial soft rot resistance. *A major emphasis will be placed on identifying, acquiring, and incorporating additional parental material into the breeding program with late blight resistance. Consideration will also be given to developing a protocol for screening progenies for late blight resistance.*

5. *The reconditioning ability of advanced selections and named cultivars will be investigated.*

6. Clones in the 8th cycle of field selection will be entered in cultural management trials and postharvest disease evaluations. Evaluations will be conducted primarily on bacterial soft rot and dry rot (Fusarium and early blight). These studies will be conducted by Dr. Susie Thompson-Johns and Dr. Robert Davidson.

FUNDING REQUEST: 1998 Allocation - $26,000
1999 Request - $28,000 [Temporary Labor - $19,000; Travel - $2,500.00; Supplies - $6,500.00]

In an effort to improve communication between the research community and the SLV potato industry the following information is being provided...

1998 potato industry assessment ($0.01/cwt on potatoes sold) - dispersed by the SLV Research Center Committee:

Member	Representing		
Jon Brownell, Chair	CPAC (Area II)	Verlin Rockey	Colorado Certified Potato Growers' Association
Mike Mitchell	CPAC (Area II)	Terry Hillin	Colorado Certified Growers' Association
Greg Colbert	CPAC (Area II)	Fran Strnad	SLV Ag Businesses
Art Holland	Grower at large		

Research Projects (Specifics of each funded project follows)	$104,000	(CSU researchers)
Aphid Suppression and Monitoring program and related research	$ 30,392	(Agro Engineering)
SLV Research Center support equipment	$ 48,434	
Total Budget for 1998	$182,826	
Funding obtained from other sources (not potato industry) for research	$ 65,000+	(CSU researchers)

A survey was completed to examine the funding generated by each state's potato industry to finance research and other related activities. State by state responses follow...

State	**Total assessment**	**Research total (ballpark figures)**
Maine *[1]15.7*	$0.05/cwt	Annual total $125,000 - $225,000 No cap
Red River Valley (Mn/ND) *41.0*	$0.03/cwt	Annual total $400,000 ($0.01/cwt) No cap
Wisconsin *24.5*	$0.04/cwt	Annual total $250,000 ($0.01/cwt)
Idaho (promotion separate) *122.0*	$0.04/cwt	Annual total $400,000 - $800,000 ($0.01/cwt) ($1.2 million max)
Oregon *23.1*	$0.04/cwt	Annual total $300,000 ($0.01/cwt)
Washington *74.1*	$0.04/cwt	Annual total $500,000 ($0.01/cwt)
Colorado *23.1*	$0.04/cwt	Annual total $200,000 ($0.01/cwt) 57% toward research, 43% toward IPM & SLVRC activities

[1]Production figures recorded in millions cwt sold (1995); based upon 1997 NPC Statistical Yearbook.

The following summaries of research projects (listed alphabetically) funded by the SLV potato industry is provided for grower information. The full annual reports are available at the CPAC office in Monte Vista or at the SLV Research Center. It is of note that the research funded in 1998 consists of a range of topics from potato diseases to production and management studies. Please take the time to review these projects and do not hesitate to provide input back to members of the SLV Research Center Committee or the individual researchers listed herein.

Title: POTATO DISEASE STUDIES

Project Leader(s): Robert Davidson; (plus R.T. Zink, A. Thompson and D.G. Holm; Early Blight Tuber Decay)

Funding: 1998 - $22,000

Project Justification: The impact on the San Luis Valley potato crop from potato diseases is significant. This impact has been reduced over the last few years by strides made in controlling some of the seedborne disease problems which have been present for years. Other non-seedborne diseases and new seedborne problems such as late blight are emerging and may be even more devastating than the previous diseases. In addition, without constant vigilance, those diseases which have been present for years may become worse with the potential loss of some chemicals, and the opportunity for new strains of the pathogens causing the disease. Growers are at a distinct disadvantage in this battle. Rising production costs coupled with the necessity to grow multiple cultivars to spread market risk, and the need to use better cultivar by cultivar growth models to maximize saleable yields, produce a greater potential for substantial crop losses because of disease.

The certified seed potato program and the seed growers in general have dedicated a large amount of energy and money to reduce the impact of potato leafroll (PLRV), mosaic viruses (PVX, PVS & PVY), blackleg (*Erwinia* spp.), and bacterial ring rot (*Cms*). Elimination or, at the very least, significant reductions in the amount of BRR, blackleg, PVX, PVS and PLRV have been seen in all certified seed lots. Seed lots with PVY mosaic problems, however, are still on the increase, primarily because of the growth of susceptible cultivars, presence of additional sources or reservoirs of disease, and dealing with latent (non-visual) infections. Additionally, newer disease problems such as early blight (*A. solani*) and late blight (*P. infestans*) have become serious threats. The impact of these diseases often is made worse by the reduction of rotation years between potato crops. Continued research of these diseases and others with potential impact in the future is warranted. Emphasis for this project is on practical, grower oriented methods of control.

Significant Accomplishments for 1998: Seventeen (BRR) and twelve (PLRV) advanced clones and six established cultivars were screened for symptom expression to BRR and PLRV. Also, tubers were evaluated for symptom expression to *Erwinia* spp., *Fusarium sambucinum* and *Alternaria solani*. All of the clones tested had adequate symptom expression to leafroll. One clone, CO86051-3, which had been screened previously, demonstrated adequate leafroll symptoms, although weaker than the standards. Several clones demonstrated high risk for in-field spread of leafroll and should be considered for potential problems in the field. BRR expression was marginal to adequate for the majority of clones tested. Clones tested for the second year had acceptable symptom expression and symptoms were within a normal time frame for expression. NDC4655-1 was an exception, however, demonstrating for the second year very weak symptoms to BRR. It will be tested for a third year. Results for the post harvest tuber evaluations indicate major differences are evident between clones. This information will be used to prepare specific management sheets.

Research related to using an integrated approach to early blight management on potato demonstrated results quite similar to 1997. Production scenarios for four cultivars with varying degrees of susceptibility to early blight tuber decay (Russet Norkotah, Centennial Russet, Russet Nugget and Ranger Russet) were compared under SLV conditions to assess their potential to cause tuber blight. Again, the results were fairly straight forward and expected. After two years of work, the following practices were ranked according to their potential impact upon tuber blight...

1. **Cultivar grown** - the more susceptible the cultivar the greater the risk (Ranger Russet-most susceptible, Russet Nugget-mid range susceptibility, Russet Norkotah and Centennial Russet-least susceptible)
2. **Fertility** - the higher the fertility...the greater the risk for predisposing the tubers to early blight, the greater the risk of immature tubers, and thus, poor skin set.

3. **Cooling of tubers immediately after harvest** - the quicker the cool down following harvest, the less the risk of tuber decay.
4. **Vine kill** - use of sulfuric acid or propane burning to kill vines, either chopped or unchopped, reduces the inoculum load on the soil surface and thus, reduces the number of *A. solani* spores available for infection.
5. **Tuber inoculation** - inoculating tubers with *A. solani* spores increases the risk of tuber decay only if the tubers are predisposed to the disease by cultivar susceptibility, immaturity, etc. Otherwise, tubers with proper maturity and skin set are quite resistant to decay, cultivar notwithstanding.

There was an effect measured on tuber predisposition to early blight decay from increased foliar fungicide applications. The tighter the interval for applications, the less the risk of tuber decay. Foliar infection of early blight did not affect levels of tuber decay. Blight disease progress curves were similar under varying treatments. There were no indications of *A. solani* isolates which differed greatly in their virulence out of the twenty + isolates collected. Finally, work with different chemistries to control early blight tuber decay is still continuing and will be ongoing into the future. It appears there are some effective products based upon the in-vitro trials, but they are not demonstrating the same level of control when applied to tubers in field trials.

Twenty Russet Norkotah plants each, either infected with PVY mosaic or healthy, were evaluated for yield and grade on four commercial fields. Average yield reductions between healthy and PVY infected plants ranged between 35 to 40%. Yield reduction on PVY infected plants was due in part to decreased numbers of tubers per plant and in large part to reduced yield of larger (>10 oz) tubers. Average infections in the fields screened were between 10 to 20% resulting in a yield loss of between 17 to 33 cwt/acre from PVY alone!

Title: Using Crops to Control Pests and Enhance Potato Production

Project Leader(s): Merlin Dillon

Funding: 1998 - $2500

Project Justification: Nematodes have become an important pest in SLV potato production and *Verticillium* (potato early dying) has been an important potato disease here for many years. Green manure crops of rape and sudan show great potential in reducing both *Verticillium* or nematodes. The effectiveness of these crops is not questioned; it has been demonstrated in other areas. What is needed, however, is information on how these crops will grow in our unique environment, especially when planted later in the season after other crops. Dedicating one entire cropping year for a green manure crop is very expensive for the growers (no crop income). Fumigants can be used to control these pests; however, these chemicals are also very expensive and soon may not be available.

Research in other areas has shown the benefit of sudan and rape crops on these pests. In our area, Dr. Richard Zink conducted three years of research into crop rotations showing the benefit of green manure sudan on reducing *Verticillium*. In that research, the sudan was planted early June and worked into the soil in late August. This project would repeat that treatment; but would also include sudan planted much later and incorporated into the soil after a hard frost. A hard frost on immature sudan produces prussic acid (HCN) which will reduce these pests in the soil.

Significant Accomplishments for 1998: Seeding winter rapeseed into growing barley was very successful. This could be helpful as a method to grow some biocontrol forage that could help control disease or nematodes in potatoes. Amounts of crop material produced at various planting dates are presented in Table 1. Sorghum-Sudan Hybrid regrowth of 1.1 ton/acre dry matter compares to the sudan green manure of 0.7 ton/acre dry matter. The sorghum-sudan regrowth harvested at frost was observedly higher than for hybrid sudan. The advantage of sudan is that the stems are smaller and incorporation is easier.

Both systems that produced hay or forage harvest on Aug 15 produced regrowth for green manure by frost. These seem the most economical in that both income and some green manure benefits are attained. As part of this study, sudan and rapeseed were broadcast into headed barley on July 15. The sudan did not germinate, but the rapeseed did germinate nicely. This might start a crop growing earlier than waiting until the crop is harvested (simulated by planting Aug 15).

Table 1. Wet Forage and Dry Matter Production of Sudan and Rapeseed

Sudan Treatments [1/]	**Wet Forage** tons/acre	**Dry Matter** %	**Dry Matter** tons/acre
June 1/Hay +	15.9	19.5	3.1
June 1/Green Manure	1.0	67.4	0.7
Total	16.9		3.8
June 1/Green Manure	7.4	58.8	4.4
July 15/Green Manure	0.6	67.4	0.4
Aug 15/ Green Manure	0.2	87.0	0.2
Rapeseed Treatments			
May 1/Hay +	18.0	12.9	2.3
May1/Green Manure	10.0	26.0	2.6
Total	28.0		4.9
May 1/Green Manure	29.8	32.1	9.6
July 15/Green Manure	2.6	32.5	0.9
Aug 15/Green Manure	1.1	25.9	0.3

[1/] Treatment shows planting date and end uses. The rapeseed is a high glucosinolate winter rapeseed, variety Humus. Planted in spring, this produces very few flowers, only forage. Planting July 15 simulates planting after early vegetable crop; planting Aug 15 is like planting after malt barley.

Title: Potato Breeding and Selection

Project Leader(s): David Holm

Funding: 1998 - $26,000

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A total of 156 samples were evaluated for two or more of the following post harvest characteristics: blackspot susceptibility, storage weight loss, dormancy, enzymatic browning, specific gravity, chip color, french fry color, and french fry texture.

Title: Characterizing and Overcoming Dormancy in Potato Minitubers

Project Leader(s): Cecil Stushnoff, Ann McSay, David Holm, Asunta (Susie) Thompson and Robert Davidson

Funding: 1998 - $6,500

Project Justification: This proposal is based upon a need to better understand mechanisms which impart post harvest dormancy in minitubers, and to develop well-defined methods to overcome dormancy. Minituber producers and their customers have encountered problems when prolonged dormancy results in sporadic and unpredictable emergence. Recent research with normal tubers has shown that dormancy is cultivar specific, it is prolonged by exposure to low temperature, and it can be defined quantitatively in terms of storage temperature and duration. The emergence of late blight in production fields may restrict minituber seed production to non-infective seasons, thus further creating a need to understand and control minituber dormancy.

To the best of our knowledge, quantitative temperature requirements to maintain, or overcome, dormancy have not been reported for most modern potato cultivars and especially not for minitubers. Apparently, various chemical dormancy breaking agents have been tried on minitubers, but with little consistent success. This might be expected if there is a strong interaction with temperature and dormancy status. It would thus be essential to first characterize the role of temperature, then optimize the potential use of growth regulating chemicals if temperature treatments alone are insufficient.

Significant Accomplishments for 1997: Tuber Dormancy: AC83064-6 had by far the least endogenous regulation of bud dormancy. Storage at 4C was essential to maintain dormancy, even then, bud break began after only 100 days, attained 50% after 130 days, and 100% after 175 days. At 8C, 50% bud break occurred after 62 days, and 12C, after only 43 days of storage.

CO85026-4 retained complete dormancy for 175 days and required 210 days for 50% bud break at 4C. Storage characteristics of CO85026-4 most closely resemble those of Russet Norkotah and Russet Nugget.

Nooksack and Russet Burbank had the strongest endogenous regulation of dormancy. At 4C bud break did not begin until after 200 days of storage, 100 days longer than AC83064-6 and 25 days longer than the intermediate group (CO85026-4, Russet Norkotah and Russet Nugget). Even at 8C, bud break did not begin until after 125 days of storage.

These data demonstrate that while storage at 4C was by far the most effective in retaining dormancy, bud break is strongly controlled by the inherent genetic features of each cultivar. Breeders, therefore, should be able to select and screen progeny to maximize development of cultivar which could be stored without using dormancy inducing substances. Identification of a gene or genes controlling endogenous dormancy would be a great asset.

Minituber Dormancy: Sub-lethal temperatures (lowest and highest temperatures permitting survival of minitubers) were determined. Dormancy of woody plant buds, and some seeds, can be overcome by exposure to stressful, but not lethal temperatures. Thus, we felt it might be productive to test this concept with dormant minitubers. Minitubers survived freezing at 2C per hour as low as -4C, but not a lower temperatures. A few minitubers broke buds after exposure to -1 and -3C. However, inconsistent response suggested this was not likely to be a promising approach.

Minitubers exposed to heat shock treatments (25 to 70C for one hour) revealed a sub-lethal survival temperature of 55C. When six cultivars and selections were given heat shock exposures for one hour over a range of temperatures (33 to 39C), the highest level of bud break occurred after a 35C heat shock treatment and incubation for bud sprouting at 18C (64F) compared to incubation at 23C (74F). In all cases sprouting was reduced at 23C, suggesting incubation temperature needs further study as well. Six, three, two and one month old minitubers were tested. As one might expect, the six-month old minitubers were most responsive. Six-month old minitubers from one cultivar, FL1867, had the highest level of bud break, and the shortest incubation time (7 days), regardless of treatment. Six-month old Ute Russet and Shepody also produced sprouts after 7 to 14 days incubation at 18C. Two-month old DT6063-1R and three-month old Russet Norkotah also responded to 33 or 35C heat shock, but three-month old Russet Nugget did not, and required 28 days incubation to produce sprouts. Galactosidase enzyme activity was highest in non-dormant FL1867. Lengthening the heat shock up to 4 hours did not improve bud break.

In summary: 1) FL1867 required the least time and broke more buds than the other cultivars, regardless of treatment; 2) incubation at 18C was far more effective than at 23C, in fact, 23C could be considered inhibitory for bud break, regardless of temperature stress treatments; 3) generally, as might be expected, six-month old minitubers stored at 4C were less dormant than two or three-month old tubers, but this effect is also confounded by cultivar response and needs further study; and 4) post harvest temperature treatments, at best, have only a minimal effect on tuber dormancy.

Title: Metribuzin Sensitivity and Model Evaluation

Project Leader(s): Asunta (Susie) Thompson and Scott Nissen

Funding: 1998 - $3,000

Project Justification: Many production factors may impact potato yields. Pest management is a critical factor. A partial listing of weeds frequently a problem in the San Luis Valley include wild sunflower, Canada thistle, green foxtail, hairy nightshade, kochia, lambsquarters, redroot pigweed, quack grass, wild oats and volunteer grain. Integrated management is typically accomplished through crop rotation, canopy competition, mechanical and chemical control.

Metribuzin, the active ingredient in Sencor and Lexone, is one of the most widely utilized chemical weed control agents. It is effective against many weed species and may provide significant partial control of quackgrass and Canada thistle; two perennial species which are difficult to control in a growing crop. Application is achieved by a variety of methods and it works effectively in tank mixes, providing a broader spectrum of weed control.

A limiting factor in using metribuzin is the sensitivity of some cultivars. The current project has a primary objective of screening advanced selections from the Colorado potato breeding program. The information obtained is included in cultivar specific management profiles and provided to producers when first trying a new selection.

Significant Accomplishments for 1998: Twenty four advanced selections and named cultivars were screened for sensitivity to a post-emergence application of metribuzin in 1998. The Russet Norkotah line selections 3 and 8 continue to display resistance, as does the standard Norkotah. Shepody, the sensitive check had an average of 33% foliar damage which equated to about a 25% yield loss. Other clones demonstrating foliar damage were CO86218-2, NDC4655-1R, AC87084-3, AC89653-3 and AC83064-6. Despite the high rate (1 lb./acre ai.) applied post-emergence, many of these selections show foliar symptoms of damage, however it does not equate into a yield loss. Generally clones must have an average of 35% or higher to result in significant yield damage. Only Shepody attained this level of damage.

Title: Cultural and Physiological Studies

Project Leader: Asunta (Susie) Thompson

Funding: 1998 - $9,900

Project Justification: The objectives of the current research program include development of cultivar specific management profiles for advanced selections and new cultivars, providing cultural management guidelines for nuclear seed producers and investigation of physiological factors related to potato production. Trials are tailored to address problems and production requirements for the San Luis Valley, however, much of what is learned may be applicable in other growing areas; i.e., providing a base level of information when trying a selection for the first time.

Development of cultivar specific management strategies may mean a more successful experience for producers and the industry, and in the development process, shortcomings of the selections may be recognized and appropriate management systems identified. Information related to nutrient management, plant population, pest susceptibilities, water requirements and storage considerations is included in management profiles. At the present time little work has been done to aid nuclear certified seed producers, however, work is scheduled on the older greenhouse complex beginning in 1999, and perhaps in the interim a local cooperator may be identified to aid in initiating some experiments. Investigations of physiological or biochemical factors provide basic information, but also impact management considerations. These aspects are then assimilated into the appropriate management profile.

Significant Accomplishments for 1998: As in previous years, the scope and number of trials conducted increased in 1998. Abbreviated results for many of the studies are presented in the following narrative. Many trials had lower yields than in previous years. This can be attributed to the hot weather prior to July fourth, followed by ten days of optimum potato production temperatures and cloudy weather, as well as the many closely spaced fungicide treatments through August which seem to slow bulking. The weather conditions also resulted in some misshapen tubers, deeper eyes and a few jelly ends.

Alpha Production - Seven production scenarios were evaluated in 1998. Early vine kill and GA treatments were not included in this years study. Marketing of Alpha requires a different grading scheme as buyers desire nothing larger than a 60 mm top. In the smallest grade (25-40 mm) double cropping produced the most, while the full-season scenario (control) and chitted treatment produced the fewest. In the 40-50 mm grade, double cropping performed most poorly, while the seed piece spacing of six inches was most superior. For the 50-60 mm category, double cropping and vine chopping provided the lowest yields and these were significantly different from the other treatments. The control and chitting resulted in the highest yields. The control and excess nitrogen treatments resulted in the highest yields of the +60 mm grade, which becomes undesirable due to too large of size. Double cropping and vine chopping had the lowest yields for this category.

Boron Rate - Two cultivars, Russet Norkotah and Russet Nugget, were produced at three rates of boron, 0, 1 or 2 pounds pre-plant incorporated. Yield was significantly different for the clones, across boron treatments, but not for boron rate across clones. For the interaction term of clone x boron, Russet Norkotah performed best with no added boron, while There were no significant differences in total yield between treatments for Russet Nugget. There were no significant differences for any grade parameters across boron treatments, however there was for clone. Russet Nugget always out yielded Russet Norkotah in this trial. This study will be repeated in 1999. It is surmised that despite our low soil readings on the southwest corner, that adequate boron is being supplied through the irrigation water.

Diquat Bulking - Five vine kill treatments were evaluated in a commercial Russet Nugget field. Harvests were conducted at 0, 14 and 21 days after treatment. The untreated check (natural vine death) was the lowest yielding treatment, while the 2 pt/acre rate of Diquat was the highest. This treatment was significantly different from the other yields. Total yields ranged from 387 cwt./acre (check) to 520 cwt./acre(Diquat @ 2 pt). US No. 1's ranged from 79 percent for the untreated check to 88 percent at the 2 pt rate of Diquat. US No. 2's and culls were not significantly different for the various treatments. Specific gravity ranged from 1.069 (sulfuric acid) to 1.078 (Diquat @ 1 pt). The difference may be attributed to speed of vine kill, continued bulking and attaining chemical maturity.

Growth Analysis - Five advanced selections were produced utilizing standard production practices. Within-row spacing was 12 inches. Weekly destructive harvests were conducted beginning at emergence. No canopy, root and tuber development profiles are reported here. BCO894-2, the very early chipper, was the lowest yielding selection. AC83064-6, Silverton Russet, was the highest yielding. Yields were not significantly different for the five selections. Russet selections tended to be higher yielding for the larger tuber grades, while the red and chipper had lower yields for these categories, and higher ones for the smaller sizes. This is acceptable as these categories generally provide the premiums for these market types.

NYL Russet Norkotah Agronomic Performance Trial - Six selections were grown at the SLVRC in 1998. The materials included four transformed selections and two controls, the standard and Colorado Selection 3. RNCTRL00-6 (CO Selection 3) was the highest yielding entry at 790 cwt./acre. The lowest yielding clone was RNBTVY15-350 at 382 cwt./acre. Ranking of the clones for yield of US No. 1 tubers matched that of total yield. US No. 1 yield ranged from 200 to 570 cwt/acre. Percent US No. 1's was low, ranging from 52 to 76 percent. Rankings differed for the entries. Colorado Selection 3 produced the most over-sized tubers, while RNBTVY15-350 had the fewest. Undersized tubers were most prevalent for RNBTVY15-350, while RNCTRL00-5 (standard control) produced the fewest in terms of yield. Bottlenecks, jelly ends, growth cracks and generally rough tubers resulted in US No. 2's and culls for all entries.

Seed Piece Spacing - Six advanced selections were produced at three within-row spacings (9, 12 and 15 inches). Yield and grade profiles indicate maximum production for the advanced selections varies by the within-row spacing. Tuber quality parameters were unaffected by within-row spacing, but occasionally varied for clone. Total yield across clones was superior at the 9 inch spacing, as were most yield components. Inferior yields were obtained at the 12 inch spacing. AC83064-6, AC87084-3, and CO85026-4 performed best at the widest spacing. Conversely, maximum yield and grade for AC88165-3 was reached at the 9 inch within-row spacing. BCO894-2, an advanced chipping selection, performed best at the narrow spacing as expected. Total yield for CO86218-2, a dark red selection which retains good skin color in storage, was superior at the narrow spacing, however the tuber grade profile was best at the 12 inch spacing. Producers should adjust within-row spacing for this clone by desired end use or premium price within the market place.

Management profiles were updated for Cherry Red and Russet Legend. Profiles near completion include Russet Norkotah compared with selections 3 and 8, Silverton Russet (AC83064-6), Keystone Russet (AC83064-1), Yukon Gold and Alpha.

Title:	Precision Farming Using Soil Mapping and Variable Rate Fertilizer Application
Project Leader(s):	Asunta (Susie) Thompson, Merlin Dillon, Kirk Thompson and Jon Gilley (Agro Engineering), Chris Sittler (Stone's Farm Supply), and Randal Ristau and Ron Riggenbach (NRCS, SLV Water Quality Demonstration Project)
Funding:	1998 - $10,300

Project Justification: Increasing yields on fields with high variability has been demonstrated using precision farming practices or Variable Rate Technology (VRT). Precision farming includes the use of GIS in conjunction with GPS to properly located and map variations in agronomic characteristics across a field. Soil texture, soil nutrient availability, crop biomass, vegetative cover, and crop yield are typical characteristics incorporated. Combined with variable rate technology, the information can be used to provide the optimum amount of nutrients, seed, water or other agrichemicals to each location within a field. Advantages of the more precise application of inputs include efficient stewardship of natural resources, and perhaps economic advantages as well.

Significant Accomplishments for 1998: Rob Jones Farm: About 132 acres were sampled on a one-acre grid basis for the second year in a row. The 1998 samples were taken in between the 1997 samples so that we would effectively have one-half acre grid samples for those nutrients that do not change considerably from one year to the next. One half of the field was planted to Russet Nugget potatoes. The other half of the field was planted to Centennial soft white wheat. Half of each crop was fertilized using VRT while the other half of each crop was fertilized using conventional practices.

The residual nitrate level ranged from 5 to 105 lbs/acre across the entire circle. Organic matter varied from 0.8% to 1.4% and pH varied from 7.9 to 8.9. Soil salinity varied from 0.15 to 0.65 mmhos/cm. These ranges were consistent with the variability noted in 1997. However, the spatial variability of nitrate and salinity was different from 1997 to 1998, being largely influenced by the previous crop. The spatial layout of organic matter was largely the same in 1998 as in 1997.

From 0 to 190 lbs/acre nitrate was variably broadcast. From 0 to 65 units per acre of phosphate was variably broadcast. From 0 to 40 units per acre of potassium was variably broadcast. From 0 to 1000 lbs/acre of gypsum was variably broadcast. The yield was then mapped using a grain yield monitor on the combine and a potato yield monitor on the harvester. The spatial variability of the yield did not correlate simply with any single soil nutrient type.

On the Russet Nugget's, the yield on the VRT portion of the field was 20 cwt/acre higher than the conventional plot and the fertilizer cost $0.69 per acre less. Assuming a $3.50/cwt return on the potatoes and including $30/acre sampling and application cost, the VRT portion still returned $40.69/acre higher than the conventional side. On the wheat, the yield on the VRT plot was 9.5 bushels/acre higher than on the conventional plot and the fertilizer cost $11.53/acre less. Assuming a $2.50/bushel return on the wheat and including sampling and application costs, the VRT portion returned $5.28/acre higher than the conventional side. This demonstrates that VRT can provide an economic incentive on variable soils where fertility is limiting crop production, even under poor market conditions.

SLVRC: In 1998 thirty acres of malt barley and 27 acres of SWS wheat were grown with precision sampling and fertilization. Fields were sampled on a one-acre grid with complete analysis of each soil sample. Only nitrogen fertilizer was varied across the field.

Malt barley nitrogen rates ranged from zero to 54 lbs/acre. The wheat rates ranged from 7 to 83 lbs/acre. This is quite different than applying one rate across the field. The heavier rates are required on the lighter, more shallow soil areas and the light rates are needed on the heavier soils. This makes sense because the heavier soils are more nitrogen efficient and, thus, need less nitrogen.

Title: Potential Losses of Eptam During Sprinkler Application and the Influences of Soil Moisture Levels at Time of Application on Efficacy

Project Leader(s): Scott Nissen and Asunta (Susie) Thompson

Funding: 1998 - $12,000

Project Justification: Eptam is an important herbicide in potato production across the U.S. In the SLV, Eptam remains one of the most consistent and economical herbicides for the control of volunteer barley and wild oat. In addition, Eptam can provide good to excellent nightshade and pigweed control; however, control of these weed species can also be highly variable. This variability in control can be the result of several factors, such as losses during chemigation, application in very high volumes of water that exceed soil infiltration rates or reduced residual activity due to increased microbial degradation.

Herbicides have traditionally been applied by chemigation in the SLV and this has provided growers with a reliable and efficient application method. Many herbicides currently used in potato production are well suited to chemigation; however, Eptam is probably not well suited to this application method. Research conducted at Washington State University suggests that temperature and wind speed can have a significant impact on Eptam losses during chemigation. Studies in the mid-west have demonstrated that continued use of Eptam can result in reduced residual activity due to enhanced microbial degradation. This research, conducted with support from the CPAC (Area II), was designed to make sure that growers achieve the best results possible from Eptam so it will continue to be a useful product for weed control in the SLV.

Significant Accomplishments for 1998: Research conducted in 1998 evaluated several remaining unanswered questions about Eptam behavior in the SLV. Previous research had established that 1) Eptam could be lost during chemigation, 2) application to wet soil or over irrigation while chemigating could result in even greater Eptam losses,

3) the residual activity of Eptam in soil is highly variable in the SLV (½ life ranging from 1 to 7 days), and 4) Eptam losses during chemigation are related primarily to air temperature and at temperatures in the range of 60 to 70F, volatility losses are significant.

A small portable chemigation unit was designed to evaluate the effects of air temperature on volatility losses of Eptam during chemigation. Water samples were collected during simulated chemigation at 6:30 am, 10:30 pm and 2:30 pm. This provided a range of air temperatures between 50 and 80F. Eptam losses increased with increasing air temperature, at 50F volatility losses averaged around 25%, while at 80F losses averaged 40 to 45%. Eptam losses increased 0.7% per one degree increase in air temperature. Reducing the nozzle height from 6 ft to 3 ft did decrease losses due to volatility, however, losses were reduced by only 9% at 80F.

Eptam degradation was evaluated under controlled conditions to evaluate residual activity in a SLV soil. Soil was collected from the field site where previous research had been conducted. The soil was a sandy loam with 0.9% OM and was collected from a field site with a barley/potato/carrot rotation. The soil was divided into two groups and kept at field capacity during the course of the experiment. Half the soil was treated three times with Eptam at 1 ppm and treatments were separated by 30 days. The remaining soil received only one application of Eptam. Eptam degradation was monitored over a 30 day period. In the soil receiving three treatments of Eptam, only 5% of the herbicide remained after 3 days, while in the soil receiving a single Eptam application, 50% of the herbicide remained intact after seven days. This project demonstrated that the half-life of Eptam under normal conditions (a single application, every other year) would be around seven days. This is very similar to previously published research. On the other hand, split applications of Eptam and use in consecutive years could result in very little residual activity. This has also been demonstrated many times.

Ground applications of Eptam followed by sprinkler incorporation could be a viable alternative to chemigation. Based on field research at the SLV Research Center, growers should be able to apply Eptam and wait up to 48 hours before sprinkler incorporation.

Demonstration plots of common potato herbicides were available for the SLV summer field tour. Eptam alone, at rates up to 6 pt/acre, did not provide adequate nightshade control, however, tank mixes with metribuzin and Matrix provided good to excellent nightshade control. Matrix is not yet available for use in the SLV.