SUMMARY RESEARCH PROGRESS REPORT FOR 1997 AND RESEARCH PROPOSAL FOR 1998

Submitted to:

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

Title: Potato Disease Studies

Project Leader(s): R.D. Davidson; plus R.T. Zink, A. Thompson-Johns and D.G. Holm (*An Integrated Approach to Early Blight Management on Potato*)

Project Justification:

The impact on the San Luis Valley potato crop from potato diseases is significant. While there have been some major strides in controlling many of the seedborne disease problems which have been present for years, other non-seedborne diseases and new seedborne problems are emerging which can be just as devastating. Growers are also at a disadvantage in this battle. In particular, growers are being hit with rising production costs, the necessity of growing multiple cultivars to spread market risk, and the need to use better cultivar by cultivar growth models to maximize saleable yield. Thus, there is a greater potential for significant crop losses because of disease.

A substantial effort has been put forth in the certified seed program to reduce the impact of potato leafroll (PLRV), mosaic viruses (PVX, PVS & PVY), blackleg (*Erwinia* spp.) and bacterial ring rot (BRR - *Clavibacter michiganensis* pv. *sepedonicus*), but success has been varied. Overall, there have been reductions in the percentage of seed lots with PLRV, blackleg and BRR. Lots with mosaic problems, however, are still increasing, primarily because of the growth of susceptible cultivars, presence of additional sources or reservoirs of disease, and dealing with latent (non-visual) infections. In addition, newer disease problems such as early blight tuber decay (*A. solani*) have become serious threats because of the loss of chemicals, the importation of diseases in seed, and the reduction of rotation years between potato crops. Therefore, 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.

Project Status:

This is an ongoing project which has been funded at various levels for the past several years. Numbered clones are graded annually for their reaction to BRR, PLRV, and common storage diseases, which includes a rating of each clone for symptom development and potential susceptibility to these diseases. Reducing the impact and spread of bacterial diseases, specifically blackleg and BRR, and the mosaic virus PVY are also areas of focus. Last year a comprehensive two year project using an integrated approach to early blight management on potatoes was funded.

Significant Accomplishments for 1997:

Sixteen (BRR) and ten (PLRV) advanced clones and six established cultivars were screened for symptom expression to PLRV and BRR. Also, tubers from sixteen advanced clones and seven established cultivars were evaluated for symptom expression to *Erwinia* spp., *Fusarium sambucinum*, and *Alternaria solani*.

All clones tested had adequate symptom expression to leafroll. In addition, three clones, AC90017-2, CO90045-4 and CO90052-1, demonstrated high risk levels for in-field spread of leafroll. BRR expression was marginal to adequate for the majority of the clones tested. Two clones, AC90017-2 and NDC4655-1 showed no BRR symptoms during the season. First year clones will be retested in 1998. Two clones, AC88042-1 and AC88162-4 which were tested for a third year in 1997 demonstrated adequate symptoms (AC88042-1) and very mild symptoms (AC88162-4). Three other clones, AC82363-3, CO86030-1 and CO86153-2 were tested in plantlet form. While all clones showed significant height increases in the healthy vs. the infected plants (1.5 to 4x taller), only one, AC82363-3, demonstrated adequate visual BRR symptom expression. The other two still showed no visual BRR symptoms and are recommended for dropping from the Cultivar Development program.

Clones with tubers tested for common storage related diseases demonstrated various symptom expressions depending upon the disease being screened and the clone being tested. Overall, there did appear to be a separation between clones and cultivars which might indicate different levels of disease susceptibility or resistance for future reference.

The project using an integrated approach to early blight management on potatoes met several of its objectives for the first year. A report was given reviewing the current project accomplishments at the 1997 Rocky Mountain Potato/Grain Conference. Production scenarios for four widely grown cultivars (Ranger Russet, Russet Norkotah, Centennial Russet, and Russet Nugget) were compared under SLV conditions to assess their potential to cause early blight tuber decay. Results from 1997 indicate that the cultivar grown has a major impact on early blight tuber decay with the most susceptible cultivars, i.e. Ranger Russet, showing the greatest damage. However, there was no significant effect due to increased fertility, increased foliar fungicide application or foliar and tuber inoculation with *A.solani* on tuber decay. In addition, there was no effect on early blight tuber decay seen between gradually cooling down tubers in storage and rapidly cooling down tubers, even when tubers were inoculated with *A.solani* spores. Preliminary indications are that a mature crop with good skin set is quite resistant to early blight tuber decay; the expected outcome of this research.

Other parts of the project which are currently ongoing looked at characterizing the virulence of *A. solani* isolates collected in the SLV, assessing and documenting the degree of early blight tuber decay in the SLV industry, and comparing different chemistries for control of early blight tuber decay. Vine kill agents were examined with a significant advantage for control of early blight tuber decay shown by either the use of sulfuric acid or the use of propane burning of the vines and soil just prior to harvest. Additionally, use of fungicides as a field applications after vine kill, but prior to harvest is being evaluated.

1998 Objectives:

1) To continue screening all numbered clones which are potential releases from the Colorado Cultivar Development program for symptom expression to BRR, PLRV, and common storage diseases.

2) To continue research dealing with an integrated approach to early blight management on potato.

Funding:

1997 Allocation:	$22,000
1998 Request:	**$22,000**

ANNUAL REPORT
1997

Submitted by:

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Introduction:

Potato disease recognition and management strategies are becoming increasing important for growers trying to produce a high quality, high yielding potato crop while maintaining production costs at reasonable levels. The unique environmental conditions found in the San Luis Valley further complicate an already difficult picture for many diseases, requiring that much of the disease research be completed within the confines of the Valley. Over the past several years, a great deal of effort has been expended to reduce the impact of five major potato disease problems; potato leafroll, tuber soft rot and blackleg (*Erwinia* spp.), bacterial ring rot, potato viruses causing foliar mosaic symptoms (PVX, PVS, PVY, PVM and PVA), and early blight tuber decay (*Alternaria solani*). Research has focused on improving certified seed lots for sale and/or recertification, understanding the epidemiology of these diseases under SLV conditions, improved screening/testing methods to detect problems before they become serious, and providing growers with management strategies to help control these disease problems when they are present. This report summarizes the results for 1997. Two objectives, clonal evaluation for symptom expression to BRR, PLRV and common storage diseases, and early blight tuber decay studies, will be covered.

Results and Discussion:

Objective 1) Sixteen (BRR & common storage diseases) and ten (PLRV) advanced clones and seven established cultivars were screened for symptom expression to PLRV, BRR and common storage diseases. Tables 1 and 2 show results from the PLRV clonal evaluations and the natural-in-field spread evaluations. All clones tested in 1997 showed adequate symptom expression for leafroll. Risk level for natural-in-field spread of leafroll was varied, but three clones, AC90017-2, CO90045-4 and CO90052-1, demonstrated a high risk level for leafroll. Established cultivars did not show any differences in risk level from previous years' data.

Tables 3 - 5 present results from the BRR clonal evaluations. BRR expression was marginal to adequate for the majority of the clones tested. Two clones, AC90017-2 and NDC4655-1 showed no visual BRR symptoms during the season. First year clones will be retested in 1998. Two other clones, AC88042-1 and AC88162-4 were tested for a third and final time in 1997. AC88042-1 demonstrated adequate visual BRR symptoms while AC88162-4 again demonstrated very mild visual BRR symptoms. This clone should be considered for dropping from the Cultivar Development program. Three other clones, AC82363-3, CO86030-1 and CO86153-2 were tested in plantlet form. All clones showed significant increases in height between the uninoculated controls and the inoculated treatments (1.5 to 4x increases). However, only one clone, AC82363-3, demonstrated acceptable visual BRR symptoms.

Tables 11 (1997) and 12 (1994) show data from the clonal evaluation for common storage diseases. Without going into detail, it is important to note that there were clear separations between clones for each of the three diseases evaluated. This will be important information for the grower as these clones are released and evaluated on their own farms.

Objective 2) (In conjunction with R.T. Zink, A. Thompson-Johns and D.G. Holm) Results from the lab and field trials conducted in 1997, Tables 6-10 and Figures 1-7, indicate that there are variations in cultivar susceptibility to early blight tuber decay, with Ranger Russet demonstrating the highest levels of disease. This information is similar to that found in 1995 and 1996. SLV production scenarios were examined for their potential to predispose tubers to early blight tuber decay using four widely grown cultivars, Ranger Russet, Russet Norkotah, Centennial Russet and Russet Nugget. There were no significant differences in tuber decay observed when excess or high fertilizer and optimum fungicide applications were used to produce immature vines and thus, immature tubers, even when foliage and tubers were inoculated with spores of *A. solani*. There were no differences observed in tuber decay when storages were cooled at different rates to affect wound healing rates, again, even when foliage and tubers were inoculated with *A. solani* spores. Preliminary indications are that this disease is manageable if tubers are mature and skin set is adequate, even with susceptible cultivars.

Other aspects of the project are still in review and/or the process of being finished. These include characterizing the SLV isolates of *A. solani*, assessing and documenting the extent of early blight tuber decay found in the SLV potato crop in 1997, comparing different chemistries for their effect against early blight tuber decay, examining the use of fungicides applied to the soil after vine kill and prior to harvest, and assessing the method of vine killing utilized. Two items of note; there are at least two chemistries which appear to have reasonable action against *A. solani* in-vitro (Table 10), and vine killing using either sulfuric acid or burning the soil and vines after vine kill, but just prior to harvest (Tables 8 and 9) appears to reduce the overall spore load in the soil and thus, reduce early blight tuber decay.

Further research in 1998 will continue the plots established in 1997 and will focus on understanding the disease under SLV conditions, understanding the strains of the fungus found in the San Luis Valley, working with new clones to identify those with some early blight tuber resistance, and working on management solutions which growers can implement in their own operations.

1997 Potato Leafroll Clonal Evaluation

Location: Corner, 9 miles North, ½ mile East

Treatments:

1) LR infected
2) Healthy

Plot Design: Randomized Complete Block - 5 seedpieces healthy planted West of 5 seedpieces LR infected.

Plant Date: 5/8/97

Plot Size: (See Plot Map)

Plant Spacing: 12 inches

Row Spacing: 34 inches

Replications: Two

Cultivars:

CO89097-2	CO90052-1	WNC230-14
AC90017-2	NDC4655-1	Centennial Russet
AC89536-5	RC92003-2	Russet Burbank
AC89653-3	NDC4438-1	Russet Nugget
CO90045-4	CO86051-3	Sangre

Irrigation: Ground Sprinkler, rate based on ET

Fertilizer: Planting fertilizer of 100, 120, 60, plus foliar applications during season at three different times, on 6/17/97, 6/27/97, and 7/14/97, for a total of 60 lbs/A N and 120 lbs/A P, for a grand total of 160, 240, 60.

Herbicide: 6/04/97 Eptam 5 pts/A, Matrix 1.5 oz/A

Insecticide: 7/25/97 Asana 8 oz/A

Harvest Date: 9/17/97 (no vine kill) - no yield data taken

Table 1. 1997 PLRV Symptom Expression in Advanced Clones and Standard Cultivars

Variety	PLRV Reaction 0-3+	Symptoms
AC89536-5	3+	LL, CC, WP, P
AC89653-3	3+	LL, CC, WP, P
AC90017-2	3+	LL, CC, WP, P
CO86051-3	2+	LL, WP, light CC
CO89097-2	3+	LL, CC, WP, P
CO90045-4	3+	LL, CC, WP, P
CO90052-1	3+	LL, CC, WP, P
NDC4438-1	3+	LL, CC, WP, P
NDC4655-1	3+	LL, CC, WP, P
RC92003-2	3+	LL, CC, WP, P
WNC230-1	0	--------
Centennial Russet	3+	LL, CC, WP, P
Russet Burbank	3+	LL, CC, WP, P
Russet Nugget	3+	LL, CC, WP, P
Sangre	3+	LL, CC, WP, P

Key - rating for the symptom expression is 0 for no symptoms to 3 for strong typical symptoms. WP = whole plant involvement, LL = lower leaf rolling, CC = good color change evident (yellowing or bronzing) and P = some purpling on leaf margin.

1997 Potato Leafroll Virus Natural-in-Field Spread

Location: Corner, 9 miles North, ½ mile East

Treatments:

1) LR infected
2) Healthy

Plot Design: Randomized Complete Block - LR + between each set of 12 healthy seedpieces/cultivar

Plant Date: 5/8/97

Plot Size: (See Plot Map)

Plant Spacing: 12 inches

Row Spacing: 34 inches

Replications: Three

Cultivars:

CO89097-2	NDC4438-1	Sangre
AC90017-2	Green Mountain	Centennial Russet
AC89536-5	Houma	WNC230-14
AC89653-3	Katahdin	Ute Russet
CO90045-4	Keswick	Russet Nugget
CO90052-1	Penobscot	
NDC4655-1	Russet Burbank	

Irrigation: Ground Sprinkler, rate based on ET

Fertilizer: Planting fertilizer of 100, 120, 60, plus foliar applications during season at three different times, on 6/17/97, 6/27/97, and 7/14/97, for a total of 60 lbs/A N and 120 lbs/A P, for a grand total of 160, 240, 60.

Herbicide: 6/04/97 Eptam 5 pts/A, Matrix 1.5 oz/A

Insecticide: 7/25/97 Asana 8 oz/A

Harvest Date: 9/17/97 (no vine kill) - no yield data taken

Table 2. 1997 Natural-in-field Spread of Leafroll to Advanced Clones

Clone #/Cultivar	# pos/ # emerged	% Spread (sd) 1997	% Spread (sd) 9 yr average	Risk
AC89536-5	2/54	3.7		Low
AC89653-3	4/52	7.7		Medium
AC90017-2	12/63	19.0		High
CO89097-2	2/55	3.6		Low
CO90045-4	7/59	11.9		High
CO90052-1	11/38	28.9		High
NDC4438-1	5/54	9.3		Medium
NDC4655-1	0/58	0.0		Low
Green Mountain	7/51	13.7	14.1	High
Houma	2/57	3.5	2.4	Low
Katahdin	1/64	1.6	2.7	Low
Keswick	4/35	11.4	5.9	Medium
Penobscot	1/48	2.1	0.4	Low
Russet Burbank	0/55	0	6.1	Medium
Sangre	0/41	0	6.2	Medium
Centennial Russet	5/33	15.2	3.3	Low
WNC230-1	0/45	0	0.0	Low
Ute Russet	0/60	0	11.5	High
Russet Nugget	4/58	6.9	14.1	High

Data is from two tubers/plant, 12 plants/replication, and three replications/ cultivar for a total of 72 tubers planted per clone in each year. Advanced clones have been tested for one year only. Risk assessment - Low = 0-4.9%, Medium = 5.0-9.9%, and High = >=10.0%.

1997 Bacterial Ring Rot Clonal Evaluation

Location: Corner, 9 miles North, ½ mile East

Treatments:

1) BRR Inoculated - placed 4-6 plates of Cms into 2 liters of Ringer's solution with bacteria scraped from plate and agar crushed and added to the solution. Tubers were cut lengthwise in half and placed in the BRR suspension for 5 minutes. BRR suspension was changed every five treatments and never kept longer than 30 minutes total time.
2) Healthy Control

Plot Design: Randomized Complete Block - 7 seedpieces of healthy planted West of 7 seedpieces BRR infected.

Plant Date: 5/12/97

Plot Size: (See Plot Map)

Plant Spacing: 12 inches

Row Spacing: 34 inches

Replications: Three

Cultivars:

AC88042-1	CO89097-2	RC92003-2	FL6 - 1900
AC88162-4	AC90017-2	NDC4438-1	WNC230-14
AC87079-3	AC89536-5	FL1 - 1835	Centennial Russet
AC87138-4	AC89653-3	FL2 - 1863	Russet Burbank
AC87340-2	CO90045-4	FL3 - 1879	Russet Norkotah
CO89036-10	CO90052-1	FL4 - 1881	Ute Russet
CO89037-7	NDC4655-1	FL5 - 1889	Sangre

Irrigation: Ground Sprinkler, rate based on ET

Fertilizer: Planting fertilizer of 100, 120, 60, plus foliar applications during season at three different times, on 6/17/97, 6/27/97, and 7/14/97, for a total of 60 lbs/A N and 120 lbs/A P, for a grand total of 160, 240, 60.

Herbicide: 6/04/97 Eptam 5 pts/A, Matrix 1.5 oz/A

Insecticide: 7/25/97 Asana 8 oz/A

Harvest Date: 9/17/97 (no vine kill) - no yield data taken

Table 3. 1997 Clonal Evaluation for Bacterial Ring Rot Foliar Symptom Expression

*	CLONE	DATE OF FIRST SYMPTOMS	# OF REPS POSITIVE	# OF PLANTS POSITIVE	% PLANTS POSITIVE	DATE 50% OR MORE +	% PLANTS + 100 DAP	SUMMARY OF SYMPTOMS	STEM SQUEEZE
3	AC88042-1	7/11/97	1	2/21	9.5%	8/8/97	61.5%	ED,R,IVC,IVN,MN,W	NEG.
3	AC88162-4	8/8/97	1	1/20	5.0%	-------	5.0%	W	NEG.
2	AC87079-3	7/25/97	1	1/21	4.7%	-------	9.5%	ED,R,IVC,MN,W	NEG.
2	AC87138-4	7/17/97	3	4/7	57.1%	7/17/97	81.0%	ED,R,IVC,MN,W	POS.
2	AC87340-2	7/17/97	2	1/7	14.3%	8/14/97	57.1%	ED,R,IVC,MN,W	POS.
2	CO89036-10	7/11/97	1	1/20	5.0%	-------	10.0%	ED,R	NEG.
2	CO89037-7	7/17/97	2	1/3	33.3%	7/25/97	66.7%	ED,R,IVC,IVN,MN,W	NEG.
2	CO89097-2	7/31/97	2	1/10	10.0%	-------	20.0%	IVC,MN,W	POS.
1	AC90017-2	-------	0	0/17	0.0%	-------	0.0%	-------	-------
1	AC89536-5	7/31/97	3	3/7	42.9%	8/8/97	61.9%	ED,R,IVC,W	POS.
1	AC89653-3	7/11/97	1	1/21	4.8%	-------	38.1%	ED,R,IVC	POS.
1	CO90045-4	7/11/97	1	1/21	4.8%	-------	14.3%	ED,R,IVC,W	NEG.
1	CO90052-1	7/31/97	2	2/20	10.0%	-------	15.0%	IVC,MN,W	NEG.
1	NDC4655-1	-------	0	0/19	0.0%	-------	0.0%	------	------
1	RC92003-2	7/17/97	2	2/21	9.5%	-------	28.6%	ED,R,IVC,MN,W	POS.
1	NDC4438-1	7/17/97	2	2/21	9.5%	-------	14.3%	IVC,MN,W	NEG.
	WNC230-14	7/17/97	1	1/21	4.8%	-------	4.8%	ED,R,IVC	NEG.
	Centennial	7/25/97	1	1/17	5.9%	-------	5.9%	ED,R	NEG.
	R. Burbank	7/11/97	3	10/21	47.6%	7/17/97	95.2%	ED,R,IVC	NEG.
	R. Norkotah	7/25/97	2	3/20	15.0%	-------	15.0%	ED,R,IVC,IVN,MN,W	------
	Ute Russet	7/17/97	1	1/21	4.8%	-------	23.8%	ED,R,IVC,MN,W	NEG.
	Sangre	7/25/97	1	1/18	5.5%	-------	27.7%	IVC,W	NEG.

* Number of Years Tested, Planting Date - 5/12/97. Key to symptoms; ED-early dwarf, R-rosette, IVC-interveinal chlorosis, IVN-interveinal necrosis, MN-marginal necrosis, and W-wilt. If the stem squeeze entry is blank, no stem squeeze was performed because there were no suspected plants or the plants were dead.

Table 4. 1997 Clonal Evaluation For Bacterial Ring Rot Tuber Symptom Expression

*	Clone	# Reps +	# Tuber +	% Tuber +
3	AC88042-1	1	4	20%
3	AC88162-4	1	1	5%
2	AC87079-3			0%
2	AC87138-4			0%
2	AC87340-2	2	9	45%
2	CO89036-10			0%
2	CO89037-7	1	1	5%
2	CO89097-2	1	1	5%
1	AC90017-2			0%
1	AC89536-5			0%
1	AC89653-3	2	4	20%
1	CO90045-4			0%
1	CO90052-1	1	1	5%
1	NDC4655-1	1	1	5%
1	RC92003-2	1	1	5%
1	NDC4438-1	1	1	5%
	WNC230-14			0%
	Centennial	1	1	5%
	R. Burbank	1	2	10%
	R. Norkotah	1	1	5%
	Ute Russet			0%
	Sangre	2	3	15%

Note: Two reps tested, ten tubers per rep.

Table 5. 1997 Clonal Evaluation for Bacterial Ring Rot Foliar Symptom Expression Utilizing Microplants

Foliar Symptoms Observed					
Clone	**# of Reps**	**7/25/97**	**7/31/97**	**8/8/97**	**Comments**
CO86153-2	2	2 Infected plants dead			Health plants 2 to 4 times larger than infected
CO86030-1	2				Healthy plants 2 times larger than infected
AC82363-3	2	2 plants, MN, IVC, IVN	6 plants, MN, IVC, IVN	6 plants, MN, IVC, IVN	Healthy plants 1.5 times larger than infected

Harvest Summarization		
Clone	**# of Reps**	**# of Tubers Positive**
CO86153-2	2	0
CO86030-1	2	0
AC82363-3	2	2

1998 Clonal Disease Evaluation

23 cultivars x 4 treatments x 5 tubers/treatment x 3 reps

Treatments

1) Control
2) *Alternaria solani*
3) *Erwinia carotovora* var. *atroseptica*
4) *Fusarium sambucinum*

Cultivars:

1) AC78069-17
2) AC83064-1
3) AC83064-6
4) AC87084-3
5) AC88042-1
6) AC88162-4
7) AC88165-3
8) AC88357-3
9) ATX85404-8
10) BCO894-2
11) CO80011-5
12) CO81082-1
13) CO85026-4
14) CO86142-3
15) CO86218-2
16) CO87009-4
17) DT6063-1R
18) Chipeta
19) Ranger Russet
20) Russet Burbank
21) Russet Norkotah
22) Russet Nugget
23) Sangre

Tuber Inoculation

Alternaria (A. solani)

- Washed spores off of *Alternaria* growth plates with sterile H_2O
- Diluted solution of spores to 1 x 10^2 *Alternaria* spores/ml.
- Bruised tubers using abrasive peeler for approximately ten seconds.
- Dipped tubers into *Alternaria* solution.
- Allowed tubers to dry.
- Placed tubers in brown paper bags and put them in 50° F cooler.

Erwinia (Eca)

- Washed *Erwinia* growth plates with sterile H_20 and centrifuged solution for 10 minutes at 5100 rpm.
- Diluted pellet into 1 ml H_20.
- Used spectrophotometer to read absorbency at 420 mμ and achieve desired dilution of 1x 10^4 cfu/ml (see chart).
- Three holes were poked in the butt-end of each tuber to be inoculated.
- 50 μl of *Erwinia* solution was placed into each hole and sealed with petroleum jelly.
- Placed tubers in brown paper bags and put them in 50°F cooler.

Fusarium (F. sambucinum)

- Washed *Fusarium* spores off of growth plate with sterile H_2O.
- Diluted spore solution to 500-1000 spores/50 μl.
- Three holes were poked in the butt-end of each tuber to be inoculated.
- 50 μl of *Fusarium* solution was placed into each hole and sealed with petroleum jelly.
- Placed tubers in brown paper bags and put them in 50°F cooler.

Summary of Treatments

Treatment	Date Inoculated	Solution	Date Evaluated
Erwinia	10/31-11/3/97	(3 x 50 µl of 1 x 10^4 cfu/ml)/tuber	2/13/98
Alternaria	11/5/97	Dipped in 1 x 10^2 spores/ml	2/16/98
Fusarium	11/7/97	(3 x 500-1000 spores)/tuber	2/11/98

Notes on Tuber Evaluation

Alternaria (A. solani)

0 - no lesions
1 - 1/8" diameter, 1 peel
2 - ¼" diameter, 2 peels
3 - ½" diameter, 3 peels, <10% tuber infection, no grade loss
4 - >10% tuber infection, or multiple 3's, loss in grade
5 - 100% tuber infection, loss in grade

Erwinia (Eca)

1 - no visual damage due to *Erwinia*
2 - localized damage
3 - <50% tuber infection, systemic, can still see individual inoculation sites
4 - >50% tuber infection, systemic
5 - 100% tuber infection, systemic

Fusarium (F. sambucinum)

1 - no visual damage due to *Fusarium*
2 - isolated spots, localized
3 - <50% tuber infection, systemic
4 - >50% tuber infection, systemic
5 - 100% tuber infection, systemic

Table 11. 1997 CLONAL DISEASE EVALUATION

Clone	Average Ratings per Tuber			% Grade Loss
	Erwinia	*Fusarium*	*Alternaria*	*Alternaria*
AC78069-17	1.1	4.1	1.1	0
AC83064-1	1.0	5.0	0.5	0
AC83064-6	1.2	4.7	0.2	0
AC87084-3	1.7	4.6	2.6	47
AC88042-1	3.1	4.6	0.6	7
AC88162-4	1.0	3.3	2.6	47
AC88165-3	1.0	4.7	3.3	67
AC88357-3	1.7	4.3	0.6	0
ATX85404-8	3.7	5.0	0.4	0
BC0894-2	1.5	4.8	0.6	7
CO80011-5	1.1	4.2	0.0	0
CO81082-1	1.4	5.0	0.3	7
CO85026-4	2.1	4.8	0.9	0
CO86142-3	2.1	4.6	0.5	0
CO86218-2	1.4	3.7	0.9	0
CO87009-4	1.1	5.0	0.7	0
DT6063-1R	1.1	4.3	2.7	47
Chipeta	1.3	4.0	0.2	0
Ranger Russet	1.0	4.4	1.0	13
Russet Burbank	1.0	4.9	1.1	13
Russet Norkotah	1.0	4.4	0.4	0
Russet Nugget	4.3	5.0	0.2	0
Sangre	2.3	2.9	0.7	0

Table 12. 1994 Clonal Disease Evaluation

Clone	Average Ratings per Tuber						% Grade Loss	
	Erwinia		*Fusarium*		*Alternaria*		*Alternaria*	
	40°F	50°F	40°F	50°F	40°F	50°F	40°F	50°F
AC78069-17	1.1	1.3	1.4	1.0	0.6	0.6	0	0
AC83064-1	1.3	1.6	1.4	1.0	0.0	0.0	0	0
AC83064-6	1.6	1.4	1.3	1.0	0.6	0.0	0	0
AC83306-1	1.5	1.4	1.6	1.0	0.9	0.6	0	0
AC84487-1	1.9	1.4	1.1	1.1	1.0	0.3	0	0
CO82142-4	2.0	1.1	2.1	2.7	1.2	0.0	0	0
CO80011-5	2.0	1.1	1.5	1.0	1.1	0.0	0	0
CO81082-1	1.6	1.3	1.4	1.0	0.1	0.0	0	0
CO84074-2	1.0	1.0	1.0	1.0	0.0	0.0	0	0
CO85026-4	1.4	1.4	1.3	1.0	0.9	0.0	0	0
Centennial Russet	1.7	1.9	1.1	1.3	0.4	0.1	0	0
Chipeta	1.1	1.6	1.6	1.3	0.1	0.5	0	0
Ranger Russet	1.3	2.0	2.1	1.4	0.3	0.0	0	0
Sangre	1.7	1.6	1.3	1.0	1.6	0.4	0	0
Russet Nugget	1.7	1.3	1.3	1.0	0.3	0.0	0	0
Russet Burbank	1.7	1.4	1.0	1.1	0.4	1.1	0	14

1997 Early Blight Fertility Trial

Location: Corner, 9 miles North, ½ mile East

Treatments:

1) Centennial Russet, Low Fertility, Sustainable 21 day interval - Bravo
2) Russet Nugget, Low Fertility, Sustainable 21 day interval - Bravo
3) Russet Norkotah, Low Fertility, Sustainable 21 day interval - Bravo
4) Ranger Russet, Low Fertility, Sustainable 21 day interval - Bravo
5) Centennial Russet, High Fertility, Sustainable 21 day interval - Bravo
6) Russet Nugget, High Fertility, Sustainable 21 day interval - Bravo
7) Russet Norkotah, High Fertility, Sustainable 21 day interval - Bravo
8) Ranger Russet, High Fertility, Sustainable 21 day interval - Bravo
9) Centennial Russet, High Fertility, Optimum 14 day interval - Bravo
10) Russet Nugget, High Fertility, Optimum 14 day interval - Bravo
11) Russet Norkotah, High Fertility, Optimum 14 day interval - Bravo
12) Ranger Russet, High Fertility, Optimum 14 day interval - Bravo

Plot Design: Randomized Complete Block

Plant Date: 5/9/97

Plot Size: (See Plot Map)
Plant/Row Spacing: 12 inches x 34 inches

Replications: Four

Cultivars: (See Treatments above)

Irrigation: Ground Sprinkler, rate based on ET

Fertilizer: Planting fertilizer of 100, 120, 60 for low rate. High rate equaled planting fertilizer plus foliar applications during season at three different times, on 6/17/97, 6/27/97, and 7/14/97, for a total of 60 lbs/A N and 120 lbs/A P, for a grand total of 160, 240, 60.

Herbicide: 6/04/97 Eptam 5 pts/A, Matrix 1.5 oz/A
Fungicide: Bravo as indicated in treatment specifications above.
Insecticide: 7/25/97 Asana 8 oz/A

Petiole Sample Dates: 7/3/97, 7/15/97, 7/31/97, and 8/15/97.
Soil Sample Dates for *A. solani* analysis: 5/9/97, 6/30/97, 7/15/97, 7/31/97, and 8/19/97.

Harvest Date: 9/17/97 (no vine kill) - no yield data taken

EARLY BLIGHT FERTILITY TRIAL

Disease Progress Curve (Mean 4 reps)

Figure 1. Centennial Russet

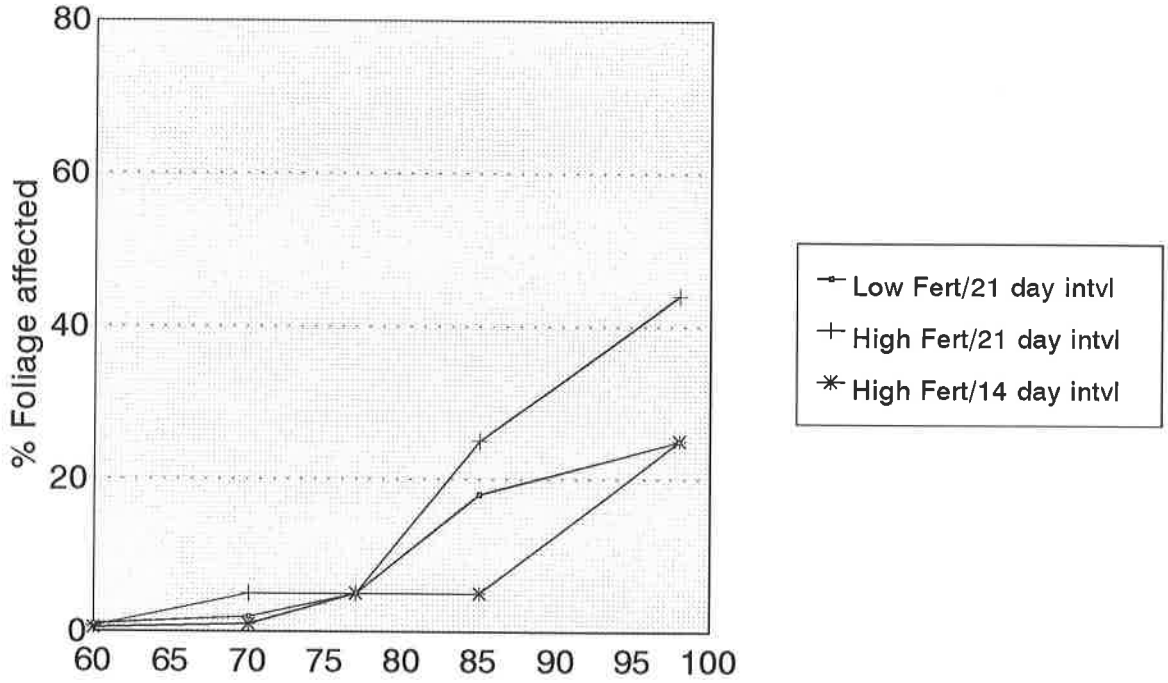
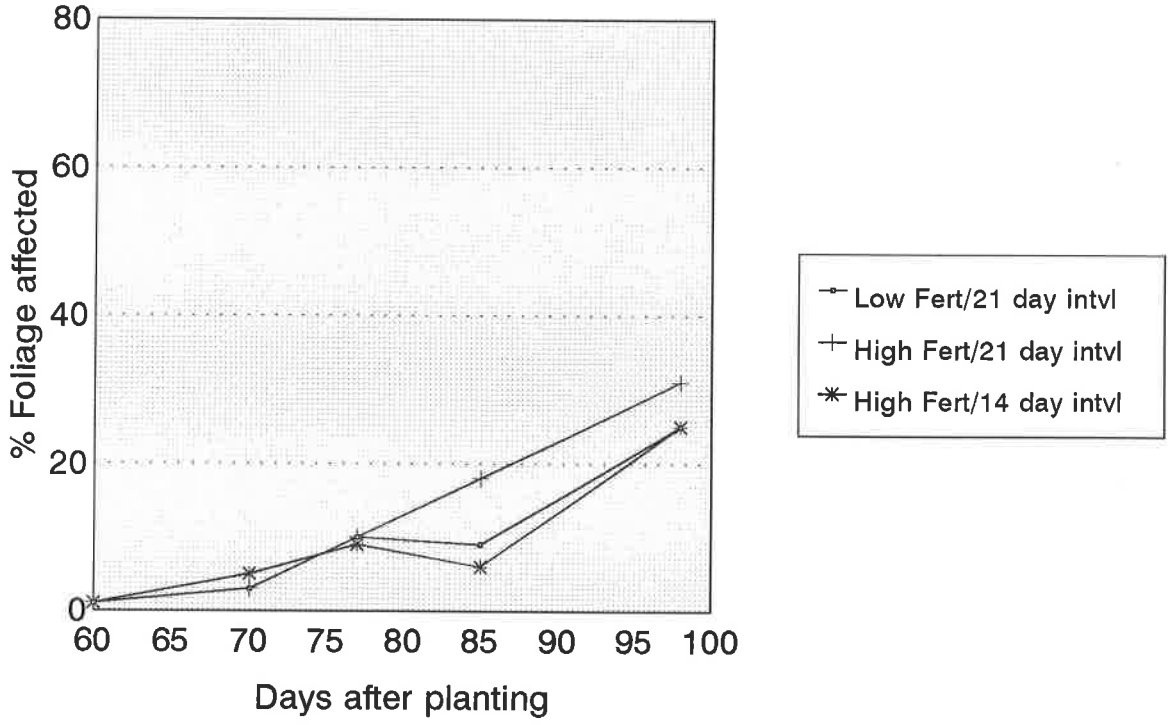


Figure 2. Ranger Russet



EARLY BLIGHT FERTILITY TRIAL

Disease Progress Curve (Mean 4 reps)

Figure 3. Russet Norkotah

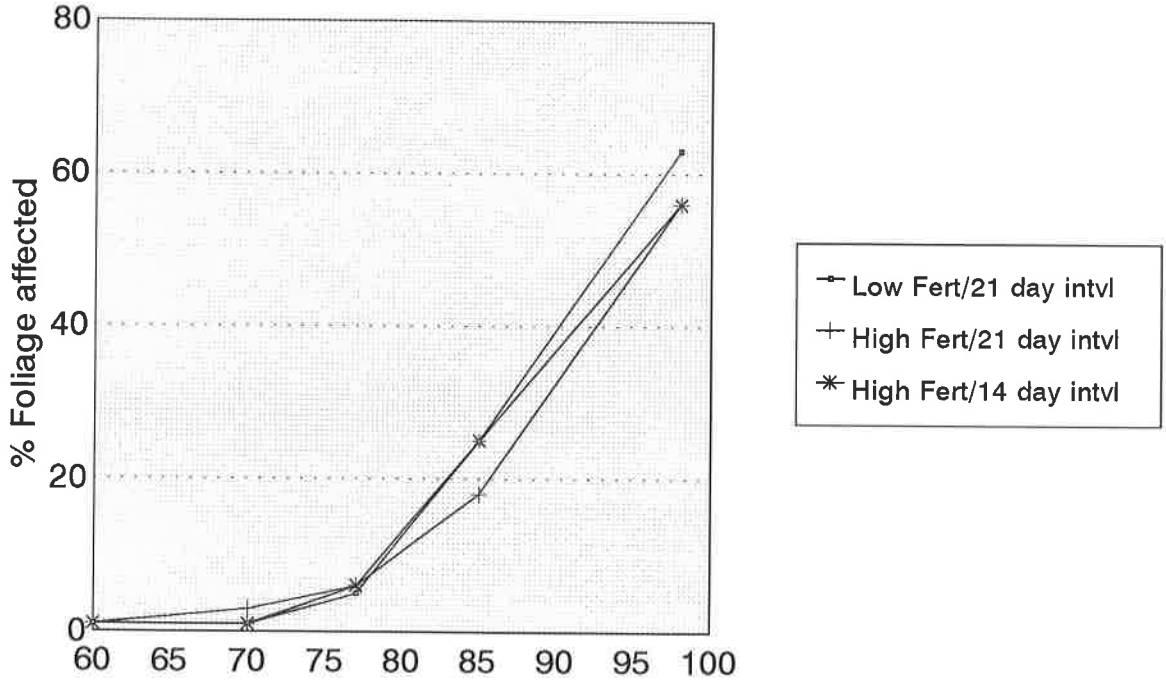


Figure 4. Russet Nugget

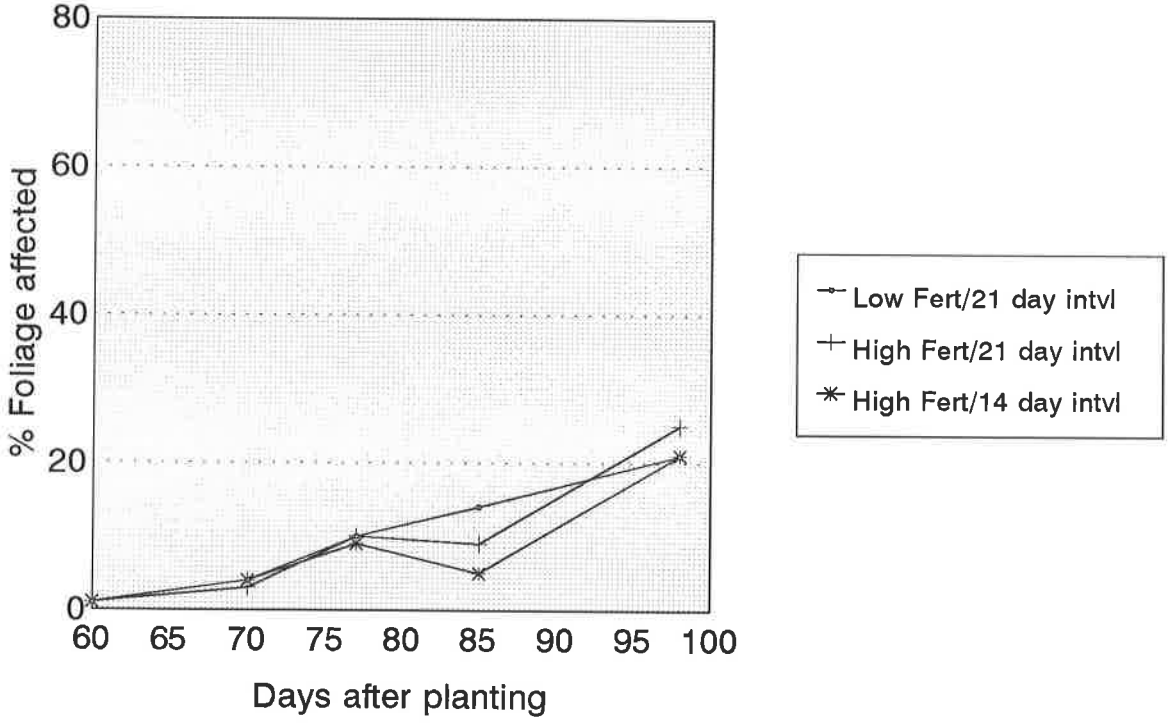


Table 6. 1997 Early Blight Fertility - Tuber Evaulation

Variety	Fertility	Fungicide	EB Inoculation	% Tubers Infected	Avg. Severity Rating	# of Tubers Sampled
Centennial Russet	Low	Sustain - 21 day intvl	no	1.6	1.3	184
Centennial Russet	Low	Sustain - 21 day intvl	yes	2.1	1.0	192
Russet Nugget	Low	Sustain - 21 day intvl	no	4.7	1.4	191
Russet Nugget	Low	Sustain - 21 day intvl	yes	0.0	-------	203
Russet Norkotah	Low	Sustain - 21 day intvl	no	2.6	1.2	194
Russet Norkotah	Low	Sustain - 21 day intvl	yes	1.0	1.0	199
Ranger Russet	Low	Sustain - 21 day intvl	no	3.1	2.0	196
Ranger Russet	Low	Sustain - 21 day intvl	yes	2.6	1.0	193
Centennial Russet	High	Sustain - 21 day intvl	no	3.0	1.0	201
Centennial Russet	High	Sustain - 21 day intvl	yes	0.5	1.0	190
Russet Nugget	High	Sustain - 21 day intvl	no	3.5	1.3	200
Russet Nugget	High	Sustain - 21 day intvl	yes	1.5	1.3	199
Russet Norkotah	High	Sustain - 21 day intvl	no	4.0	1.5	198
Russet Norkotah	High	Sustain - 21 day intvl	yes	1.5	1.0	199
Ranger Russet	High	Sustain - 21 day intvl	no	6.3	1.3	189
Ranger Russet	High	Sustain - 21 day intvl	yes	7.6	1.7	197
Centennial Russet	High	Optimum - 14 day intv.	no	2.6	1.4	192
Centennial Russet	High	Optimum - 14 day intv.	yes	0.5	1.0	198
Russet Nugget	High	Optimum - 14 day intv.	no	1.0	2.0	198
Russet Nugget	High	Optimum - 14 day intv.	yes	3.0	1.2	199
Russet Norkotah	High	Optimum - 14 day intv.	no	0.5	1.0	198
Russet Norkotah	High	Optimum - 14 day intv.	yes	2.0	1.3	197
Ranger Russet	High	Optimum - 14 day intv.	no	8.1	1.4	197
Ranger Russet	High	Optimum - 14 day intv.	yes	4.1	1.8	196

1997 Early Blight Model/Storage Trial

Location: Corner, 9 miles North, ½ mile East

Treatments:

1) Russet Norkotah, Positive Inoculation, Stored at 38° F -cooled at once.
2) Centennial Russet, Positive Inoc., Stored at 38° F -cooled at once.
3) Russet Nugget, Positive Inoc., Stored at 38° F -cooled at once.
4) Russet Norkotah, Positive Inoc., Stored at 38° F -gradual cool down.
5) Centennial Russet, Positive Inoc., Stored at 38° F -gradual cool down.
6) Russet Nugget, Positive Inoc., Stored at 38° F -gradual cool down.
7) Russet Norkotah, Negative Inoc., Stored at 38° F -cooled at once.
8) Centennial Russet, Negative Inoc., Stored at 38° F -cooled at once.
9) Russet Nugget, Negative Inoc., Stored at 38° F -cooled at once.
10) Russet Norkotah, Negative Inoc., Stored at 38° F -gradual cool down.
11) Centennial Russet, Negative Inoc, Stored at 38° F -gradual cool down.
12) Russet Nugget, Negative Inoc., Stored at 38° F -gradual cool down.

Plot Design: Randomized Complete Block

Plant Date: 5/9/97

Plot Size: (See Plot Map)

Plant/Row Spacing: 12 inches x 34 inches

Replications: Four

Cultivars: (See Treatments above)

Irrigation: Ground Sprinkler, rate based on ET

Fertilizer: Planting fertilizer of 100, 120, 60, plus foliar applications during season at three different times, on 6/17/97, 6/27/97, and 7/14/97, for a total of 60 lbs/A N and 120 lbs/A P, for a grand total of 160, 240, 60.

Herbicide: 6/04/97 Eptam 5 pts/A, Matrix 1.5 oz/A
Fungicide: Bravo 1.5 pts/A - 14 day intervals
Insecticide: 7/25/97 Asana 8 oz/A

Soil Sample Dates for *A. solani* analysis: 5/9/97, 6/30/97, 7/15/97, 7/31/97, and 8/19/97.

Harvest Date: 9/17/97 (no vine kill) - no yield data taken

EARLY BLIGHT MODEL/STORAGE TRIAL

Disease Progress Curve (mean 4 reps)

Figure 5. Russet Norkotah

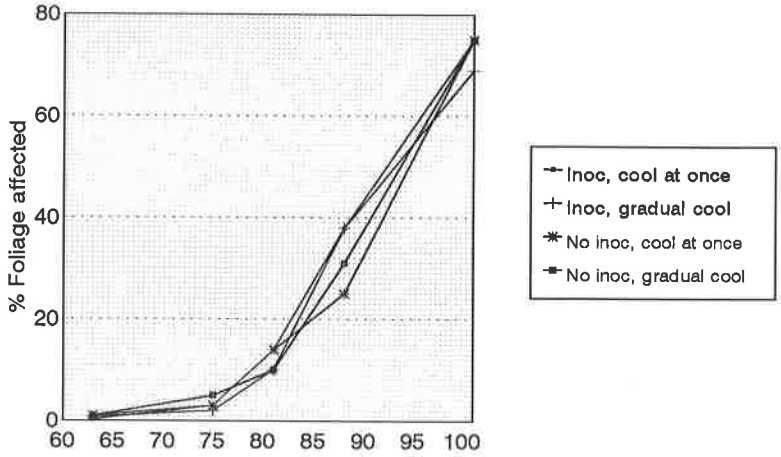


Figure 6. Russet Nugget

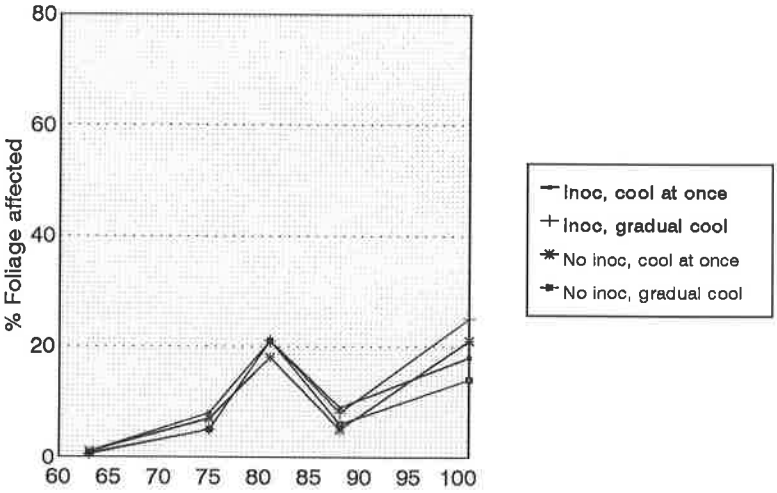


Figure 7. Centennial Russet

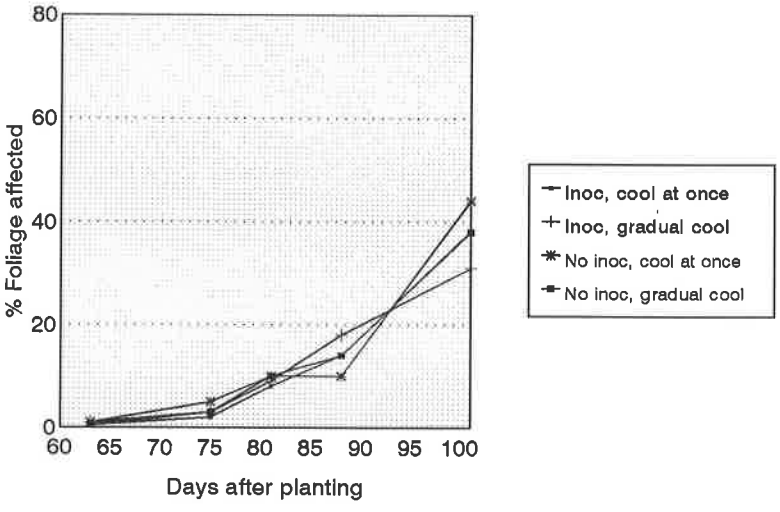


Table 7. 1997 Early Blight Model/Storage - Tuber Evaluation

Variety	Field Inoculation	Storage	EB Inoculation	% Tubers Infected	Avg. Severity Rating	# of Tubers Sampled
Russet Norkotah	yes	38°F - cool at once	no	9.0	1.5	200
Russet Norkotah	yes	38°F - cool at once	yes	4.5	1.6	199
Centennial Russet	yes	38°F - cool at once	no	3.9	1.6	205
Centennial Russet	yes	38°F - cool at once	yes	4.0	1.4	199
Russet Nugget	yes	38°F - cool at once	no	4.5	1.7	202
Russet Nugget	yes	38°F - cool at once	yes	8.5	2.1	199
Russet Norkotah	yes	gradual cool down	no	4.5	1.4	177
Russet Norkotah	yes	gradual cool down	yes	5.7	1.6	193
Centennial Russet	yes	gradual cool down	no	3.1	1.3	195
Centennial Russet	yes	gradual cool down	yes	3.7	1.4	189
Russet Nugget	yes	gradual cool down	no	5.1	1.5	197
Russet Nugget	yes	gradual cool down	yes	4.6	1.4	194
Russet Norkotah	no	38°F - cool at once	no	1.9	1.3	206
Russet Norkotah	no	38°F - cool at once	yes	2.5	1.4	198
Centennial Russet	no	38°F - cool at once	no	3.0	1.3	198
Centennial Russet	no	38°F - cool at once	yes	5.6	1.5	198
Russet Nugget	no	38°F - cool at once	no	0.5	1.0	200
Russet Nugget	no	38°F - cool at once	yes	4.0	1.6	201
Russet Norkotah	no	gradual cool down	no	3.5	1.4	199
Russet Norkotah	no	gradual cool down	yes	2.5	1.6	197
Centennial Russet	no	gradual cool down	no	1.5	1.3	197
Centennial Russet	no	gradual cool down	yes	1.6	1.0	193
Russet Nugget	no	gradual cool down	no	4.0	1.3	199
Russet Nugget	no	gradual cool down	yes	2.1	1.0	192

Table 8. Early Blight Tuber Screening

Year	Cultivar	Vine Kill	Control		*Alternaria solani*	
			%	Severity	%	Severity
1995	[A] Ranger Russet	Diquat	73	45.0	96	194.0
1996	[A] Ranger Russet	Acid	5	2.0	15	8.0
1995	[B] Ranger Russet	Champ/Diquat + Acid	0	0.0	55	76.0
1996	[C] Ranger Russet	Diquat	13	8.0	35	37.7
1995	[B] Century Russet	Acid	17	2.3	56	24.5
1995	[B] Century Russet	Champ/Diquat + Acid	39	8.7	50	15.7
1996	[D] Russet Norkotah	Acid	0	0.0	8	2.0

[ABCD] Represents growers, shows which samples are from the same growers.

Table 9. 1997 Results from Fields Vine Killed with Propane

Field	Alternaria Spores/gram of soil		% Decrease
	No Burn	Burn	
1	42.4	25.0	41%
2	10.0	6.6	34%

Table 10. In-vitro Trials for Inhibition of *A.solani* - 1997.

	Kocide 2000 (Copper Hydroxide)				Dithane ST (EBDC)		
	Trial 1		Trial 2		Trial 1		Trial 2
ppm[a]	Spread[b]	Core[c]	Spread	Core	Spread	Core	Spread
0 (WA)	2	1.50	1	1.00	1	1.00	1
1	2	1.50			1	0.75	
5							
10	1	1.50	1	0.75	1	1.00	
25			1	0.50			1
50			3	0.50			1
75			3	0.25			
100	5*	0.13	4	0.25	3	0.38	2
250							2
375							
500							3
750							
1000	5	0.13			5*	0.13	4
10000	5	0.13			5	0.13	

[a]ppm = parts per million of Dithane ST active ingredient and Kocide 2000 formulation (53.8% copper hydroxide).

Test compounds were added undiluted to 50°C water agar, mixed and poured into petri dishes.

[b] *A. solani* suspension planted on water agar - each plate rated on a scale of 1-5; 1 = general growth across plate, 5 = no growth.

[c] A. solani core removed from A. solani water agar plates and placed on test plates - initial core = 0.13" in diameter; Growth zone around cores measured as diameter in inches.

* Effective in-vitro levels for control of *A. solani*; Kocide = 100 ppm+, Dithane ST = 1000 ppm+.