REDUCING SEEDPIECE DECAY

W. R. Stevenson[1/] and R. V. James[2/]

The seed-handling and planting aspects of potato production are among the most critical decisions faced by growers. Failure to recognize potential problems related to seedpiece decay, and failure to take corrective action, can result in erratic or delayed emergence. This in turn may lead to field replanting or retarded growth early in the growing season which then affects harvest scheduling, yield, marketability and crop profitability. Seedpiece decay, stand loss, and loss of plant vigor pose major production risks to Wisconsin growers. Numerous growers have experienced significant reductions in plant stands and loss of plant vigor during the past several growing seasons. Slow-emerging plants, plants with poor vigor and missing hills are often associated with bacterial soft rot of the planted seedpiece caused by *Erwinia carotovora* pvar. *atroseptica*, (Eca). During recent years, *Fusarium* seedpiece decay, has become more serious for several growers especially when seed tubers arrive at their farms badly bruised and already infected with the *Fusarium* pathogen. In an effort to better understand the primary factors contributing to seedpiece decay, we initiated an extensive research project that focuses on the relationship between seed and seed handling, decay organisms and the planting to emergence environment. We divided our efforts between field experiments and use of the University of Wisconsin Biotron facility that allows us to simulate field conditions in controlled experiments. These studies have allowed us to explore how changes in aspects of seed handling and environmental extremes affect seedpiece decay and plant emergence. Ultimately these studies will help to refine our disease control recommendations and, in fact, results of some of our experiments are already being successfully used by many Wisconsin growers. A review of these studies will help to define our current understanding of seedpiece decay and methods that can be used by growers to reduce their losses.

Biotron Studies

During the past five years, we conducted over 168 separate experiments in the controlled environment facilities of the UW Biotron where we continue to evaluate variables that relate to seedpiece decay and crop emergence. Variables used in these experiments included: potato cultivar, soil type, temperature of seed at cutting and during the 14 days before cutting, precutting and wound healing, temperature during the wound healing period, duration of the healing period, soil temperature at planting and the 14 day period after planting, soil moisture at planting and during the emergence period, pathogen inoculation (*Erwinia carotovora* pvar. *atroseptica* and *Fusarium solani* 'Coeruleum', and treatment with standard fungicides (captan and thiophanate). From the standpoint of

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1/ Vaughan-Bascom Professor, Department of Plant Pathology, University of Wisconsin, Madison, WI 53706

2/ Research Specialist, Department of Plant Pathology, University of Wisconsin, Madison, WI 53706

logistics and practicality, we have focused on two cultivars (Russet Burbank and Atlantic) and two soil types (Plainfield loamy sand and Antigo silt loam) since combinations of these variables represent important cultivars grown in the state in two important production areas. In addition to these combinations of cultivar and soil type, we are now adding experiments that include the Norland and Superior cultivars and Houghton muck soil type. We have shown that practical methods which enhance healing of potato seedtubers, decrease the potential for bacterial seedpiece decay and the need for chemical treatments. In general, seedpiece decay initiated by bacterial pathogens is lowest and emergence is highest when wound-healed seedpieces are planted into cool to warm soil with moderate moisture. Conversely bacterial seedpiece decay is highest and emergence is lowest when freshly cut seedpieces are planted into warm dry soil and the soil becomes saturated during the next week. When bacterial seedpiece decay is the primary pathogen, there is little need or advantage to using a commercial fungicide dust on the cut seed. When *Fusarium solani* is added to the planting equation at the time of seed cutting or planting, however, the picture changes dramatically. We have observed that if tubers are inoculated with *F. solani* at the time of seed cutting and cut seed is kept under conditions conducive to wound healing (ventilation, high relative humidity, warm temperatures), *Fusarium* decay of the seedpieces will be a major limiting factor after planting. If precut and healed seedpieces are inoculated with *Fusarium* at planting or planted into soil with the *Fusarium* fungus, losses are minimal. Application of captan or thiophanate fungicides at the time of cutting generally reduces the amount of *Fusarium* decay that occurs. Best results (low decay and maximum emergence) are generally obtained if seedpieces are pre-cut and the seedpiece treatment is present during the healing period. Application of captan or thiophanate dusts to fresh cut seedpieces immediately before planting can be detrimental, however, increasing the potential for losses. Use of biological materials currently available for testing provides no consistent benefit in the control of *Erwinia* or *Fusarium* infection.

During the past year we focused our Biotron experiments on the effects of soil saturation on seedpiece decay in an attempt to mimic the conditions that prevailed in many commercial fields in Wisconsin during the planting and emergence period. We observed that there is generally the least decay when seedpieces are healed 3-6 days and planted in moderately moist soil. Decay is most severe and emergence poorest if soil is saturated soon after freshly cut seedpieces are planted or if soil is very dry at planting and then becomes saturated. If freshly cut seedpieces are planted in moderately moist soil, they appear to be able to withstand saturated soil sooner than if they were placed in dry soil. If soil is saturated immediately after planting, levels of decay are high regardless of healing or inoculation. When soil is dry to moderately moist, bacterial soft rot is generally controlled by healing alone, but if inoculated with *Fusarium solani*, healing, combined with selected fungicide seedpiece treatment is likely to provide the best control.

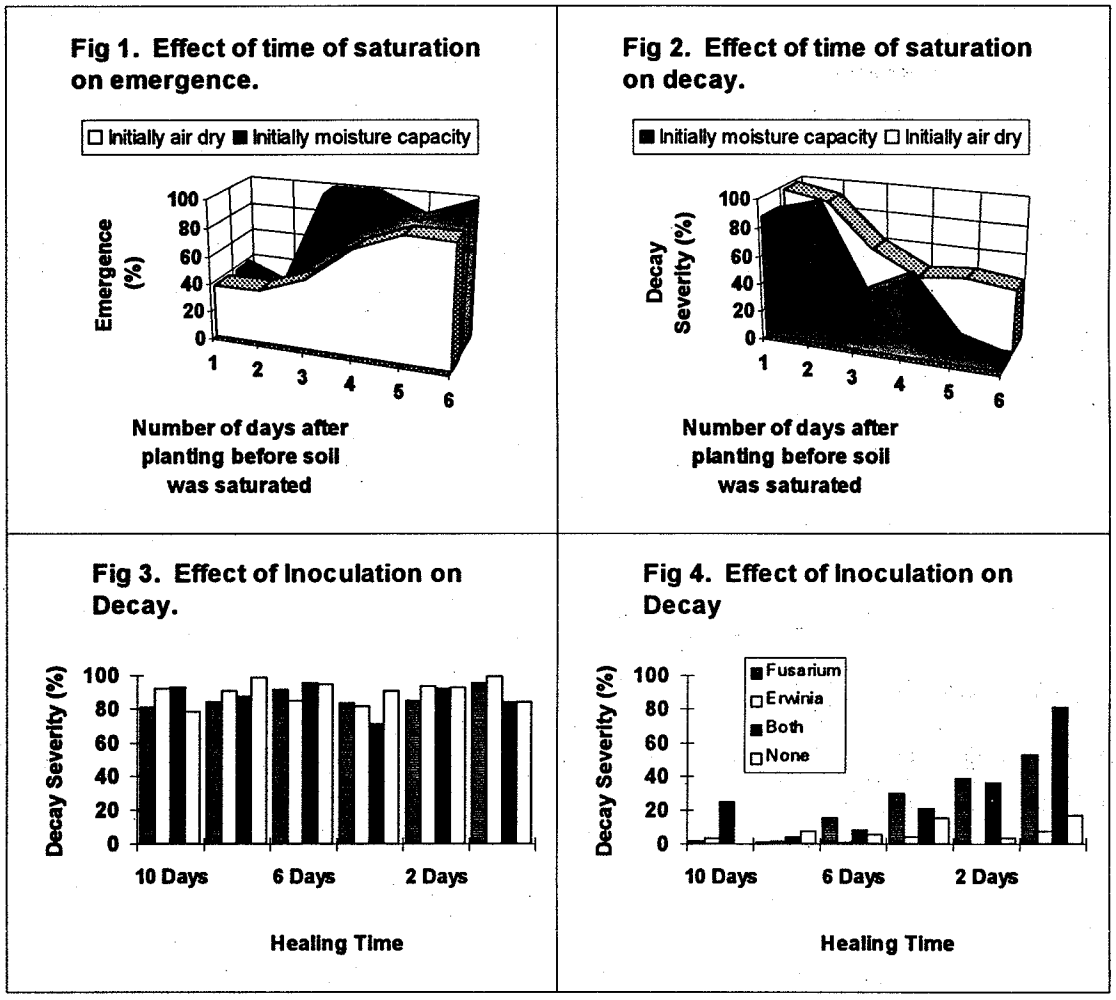

Fig. 1-4. Data are from experiments conducted in the Biotron year under temperature conditions representative of the spring of 1993 in Wisconsin - 22° C (5 days), then 10° C (7 days), then 16° C (15 days). The soil warmed early but cooled off substantially after planting due to cold weather. Fig. 1 and 2 show the effects on decay and emergence of soil saturation at different times after planting for Atlantic seedpieces planted in Antigo silt loam soil. Fig. 3 and 4 show the effect of inoculation and healing on seedpiece decay for Atlantic seedpieces planted in Plainfield loamy sand. Fig. 3 - soil saturated for five days after planting, then maintained at field moisture capacity. Fig. 4 - soil air dry for five days after planting, then maintained at field moisture capacity.

Field Studies at Antigo, Hancock, Palmyra and Spooner, WI

Field trials are conducted each year at multiple sites. This past year, trials were conducted at the Hancock and Spooner Agricultural Research Stations, the Langlade County Airport and Dean Kincaid Farms, Inc., Palmyra, locations representing a range of environmental conditions and distinct soil types. A range of chemical treatments, healing periods and bruising severities were evaluated for their effect on seedpiece decay, emergence, plant vigor and yield. (Specific details on these trials are included in this volume of proceedings, in the submission entitled "Evaluation of strategies for improved potato disease management").

Antigo:

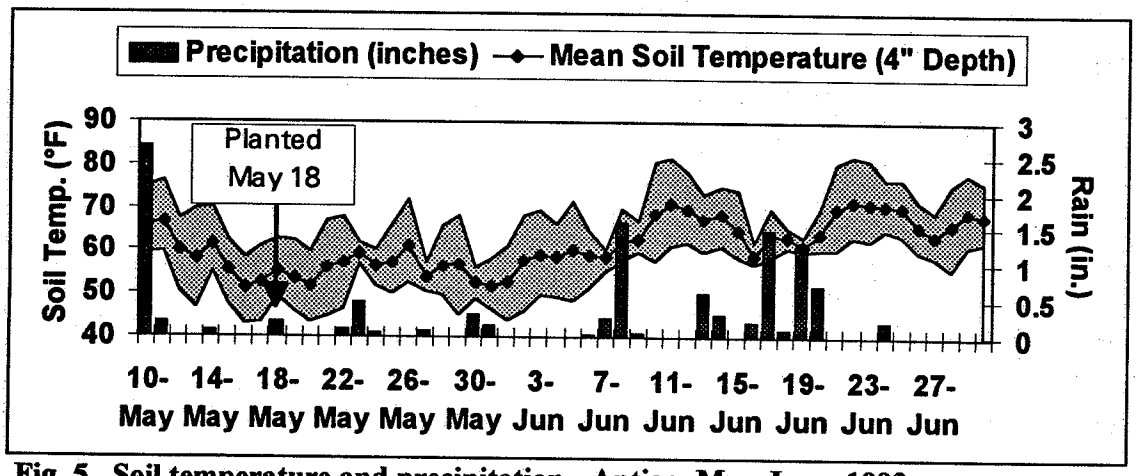

Fig. 5. Soil temperature and precipitation - Antigo, May-June, 1993.

Environmental conditions were generally favorable for emergence and early season plant development (Fig. 5). Emergence and plant vigor were highest when seedpieces were cut and healed for three or more days before planting. Chemical treatment of freshly cut seedpieces did not improve emergence. Significantly less seedpiece decay was observed in plots planted with seedpieces cut and healed for 1-11 days, left untreated with chemicals. Significant differences in Rhizoctonia infection were observed, but clear-cut conclusions could not be drawn from the data. The lowest amount of Rhizoctonia was observed in plots planted with freshly cut seed treated with Captan fungicide. Total yields were generally above 300 cwt/acre with lowest yields observed in plots where freshly cut seedpieces were bruised and inoculated before planting. Yields tended to be higher when seedpieces were cut and healed before planting, but differences were not significant. Over the past several years of field testing, we have observed the greatest levels of seedpiece decay on fresh cut and planted seed and the least amount of decay on seed healed for 1 day or more (Fig. 6) .

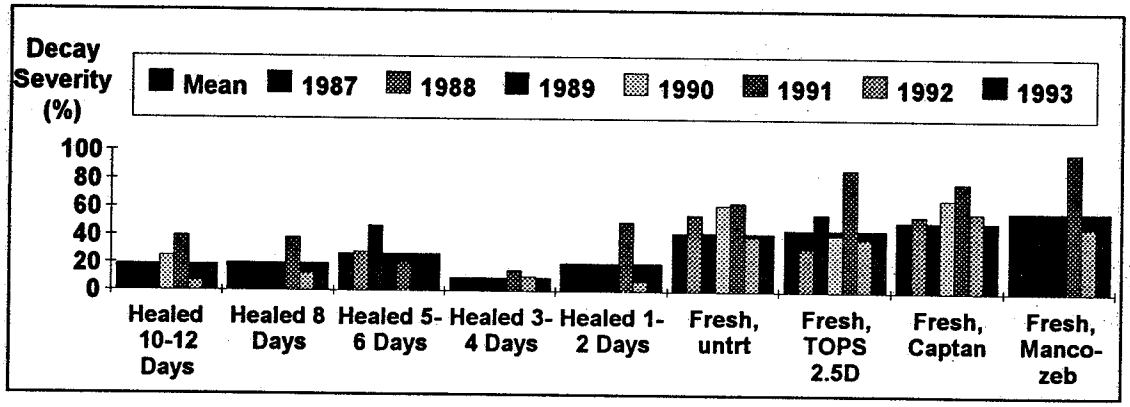

Fig. 6. Mean seedpiece decay in the field - Atlantic, Antigo: 1987-1993.

Hancock:

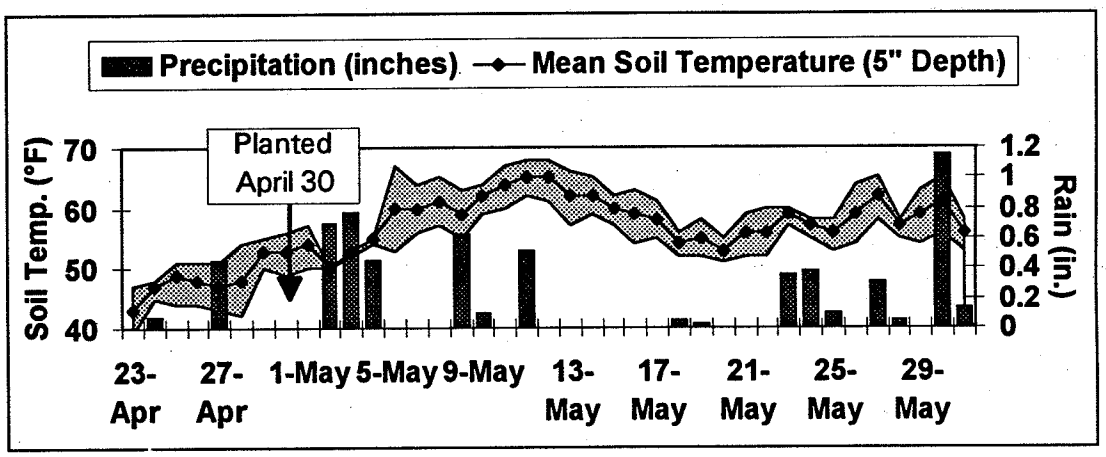

Fig. 7. Soil temperature and precipitation - Hancock, April-May, 1993.

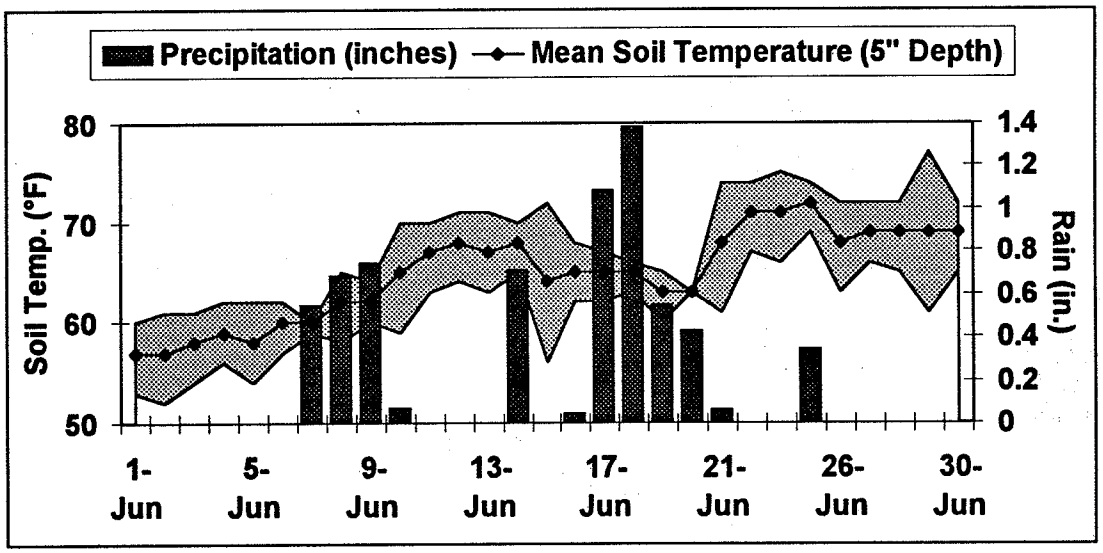

Fig. 8. Soil temperature and precipitation - Hancock, June 1993.

Conditions at planting on April 30 (moist soil and temp in the mid 50's) were ideal for in-field healing of cut seedpieces, but within 48 hours of planting, weather conditions deteriorated (Fig. 7 and 8). Three consecutive days of rainfall and then five days of air temperatures > 75° F brought soil temperatures to the mid to upper 60's, conditions ideal for the development of seedpiece decay, especially on seedpieces inoculated with *Eca* and *Fusarium solani.* These conditions were typical of growers in the area. Growers who continued to plant their fields with freshly cut seedpieces up to the time the rains began, experienced severe seedpiece decay problems and many fields planted during this time were replanted about 2 weeks later.

Atlantic: Highest emergence and plant vigor was observed with seed that was cut and healed 2-11 days before planting (Fig. 9). Planting freshly cut seed

significantly reduced crop emergence and plant vigor, but inoculation of freshly cut seed with *Eca* or *Fusarium* had an even greater impact. Inoculation of freshly cut Atlantic seed with *Fusarium* reduced emergence to 28% in contrast to 88% for seed healed 2 days before planting. Lowest seedpiece decay was observed in plots planted with healed seed (4-7 days healing seemed to be optimum). Blackleg was generally most severe in plots inoculated with *Eca*. Incidence of *Rhizoctonia* was variable. Stem numbers, plant height and daughter tubers per hill were greatest in plots planted to healed seedpieces. Plants in plots planted with healed seed generally produced a more uniform size distribution of tubers than did plants in plots planted with freshly cut seedpieces where there were more tubers in the 6-13 oz category, a reflection of poor stands in the latter plots. Yields were significantly higher in plots planted to healed seedpieces. Specific gravities were unaffected by seed treatment. Precutting and healing for 2 and 4 days before planting without chemical application appeared to be the optimum treatment for this cultivar.

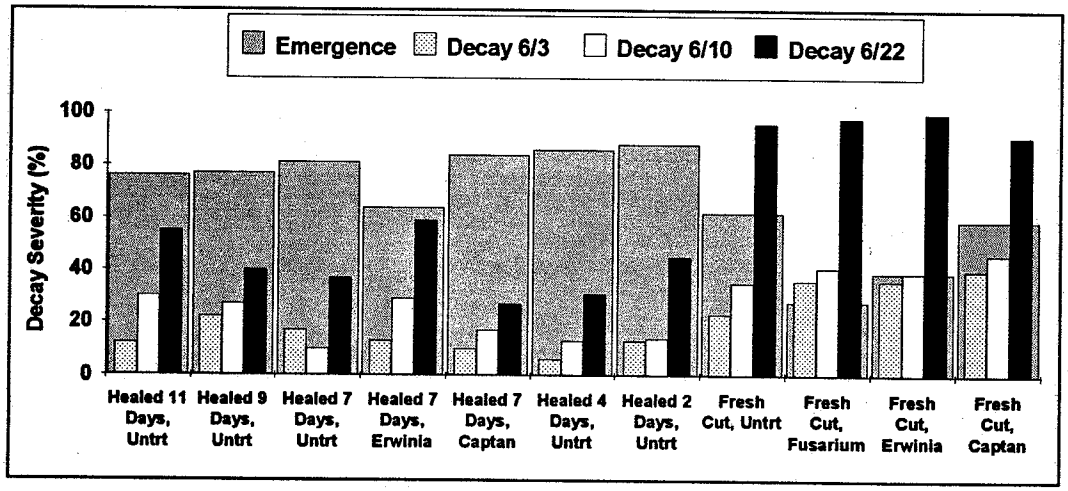

Fig. 9. Seedpiece decay and Emergence - Atlantic, Hancock - 1993.

Dark Red Norland: Emergence and plant vigor was highest with seed that was cut and healed 2-7 days before planting. Inoculation of seedpieces with *Eca* severely reduced emergence and plant vigor whether the seed was healed for 7 days after inoculation or planted immediately. Application of Captan to seed before healing or to freshly cut seed just before planting did not improve emergence or plant vigor. Seedpiece decay was generally highest on freshly cut seed although the application of Captan seemed to reduce decay severity. The number of stems per plant, plant height and the number of daughter tubers per hill was generally higher in plots planted with healed seedpieces. *Erwinia* inoculation significantly reduced each of these parameters. Total yield and yield of US#1A tubers were also highest in plots planted with healed seedpieces. Application of Captan did not improve yield above the untreated checks. Plots planted with freshly cut seedpieces produced a broader size distribution of tubers than did plots planted with healed seedpieces where the majority of tubers were in the < 4oz and 4-6 oz categories. Specific gravities were unaffected by seed treatment. The optimum treatments for this cultivar included precutting and healing the seedpieces for 2-7 days before planting.

Russet Burbank: Healing fresh cut seed for 2-11 days before planting significantly improved emergence and vigor over freshly cut seed (Fig. 10). Inoculation of cut seed with *Eca* and *Fusarium* significantly reduced emergence and

plant vigor. None of the chemical treatments applied to freshly cut seed at the time of planting improved crop emergence or vigor over the untreated check. Seedpiece decay was lowest on seed that was cut and healed for 2-11 days before planting. Chemical treatment of cut seedpieces did not significantly reduce seedpiece decay. Blackleg was somewhat lower on plots planted with healed seedpieces, but most plots had at least one plant with blackleg symptoms. *Rhizoctonia* infection was variable, but many of the fungicide treatments appeared to provide some control of this disease. The fungicide Maxim continued to provide excellent control of *Rhizoctonia* and appears to be a promising new product. Stem numbers, plant height, daughter tubers and yield were generally higher in plots planted with healed seed. Dropping and *Eca* inoculation of seed that was then healed for 7 days before planting had less effect than the same treatments applied to freshly cut seed just prior to planting. Inoculation of freshly cut seed with *Eca* and *Fusarium* just before planting resulted in very poor emergence and yield. Specific gravities were unaffected by seed treatment. Seed treatment had a significant impact on overall sizing of tubers. Precutting and healing for 2 and 7 days before planting without chemical application appeared to be the optimum treatment for this cultivar.

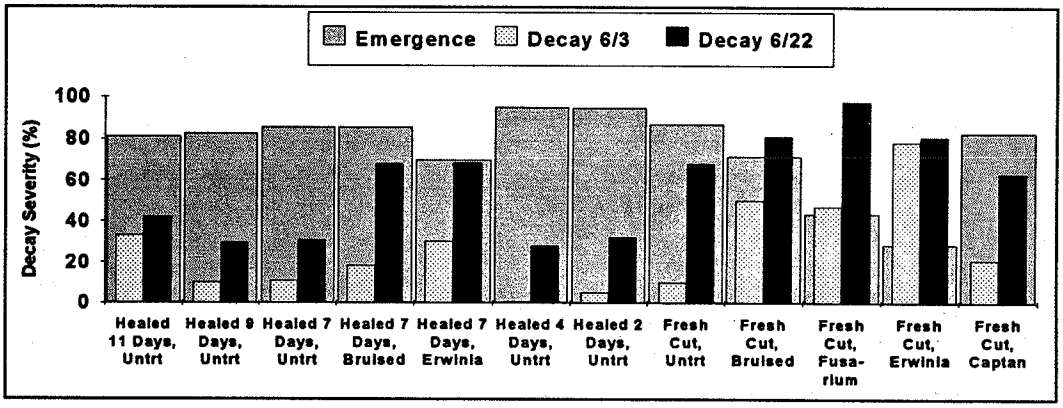

Fig 10. Seedpiece decay and emergence - Russet Burbank, Hancock - 1993.

Spooner:

Weather conditions after planting were generally favorable for wound healing and plant emergence and final emergence and plant vigor for all treatments were similar (Fig. 11). However, bruising of freshly cut seed just before planting slowed early emergence and resulted in more decay in the mist chamber. In the field, seedpiece decay was greatest on fresh cut seedpieces left untreated with fungicide dust and untreated seedpieces healed 1 and 3 days before planting. Seedpiece treatment did not affect blackleg, Rhizoctonia stem infection, the number of stems per plant or average plant height. Yields were not significantly affected by seedpiece treatment. Highest yields were observed in plots planted with freshly cut seed and seed that was healed for 4 days before planting.

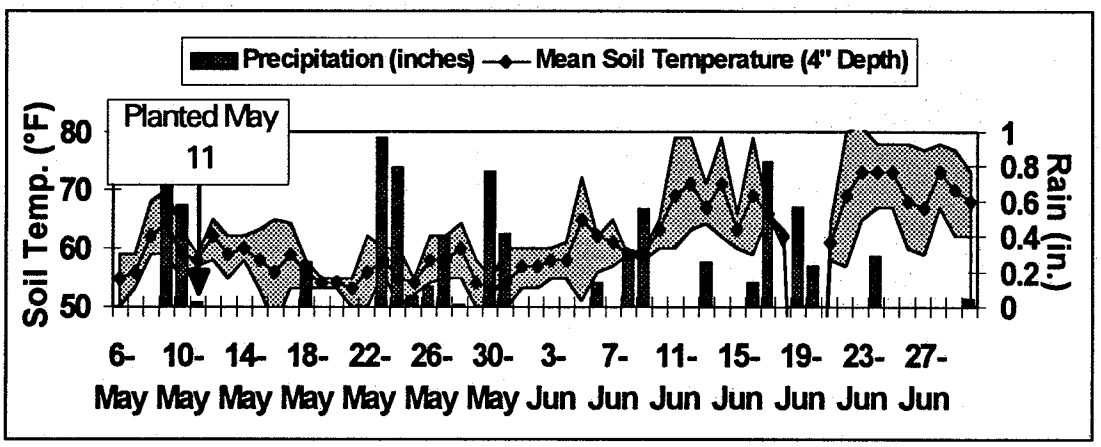

Fig. 11. Soil temperature and precipitation - Spooner, May-June, 1993.

Palmyra:

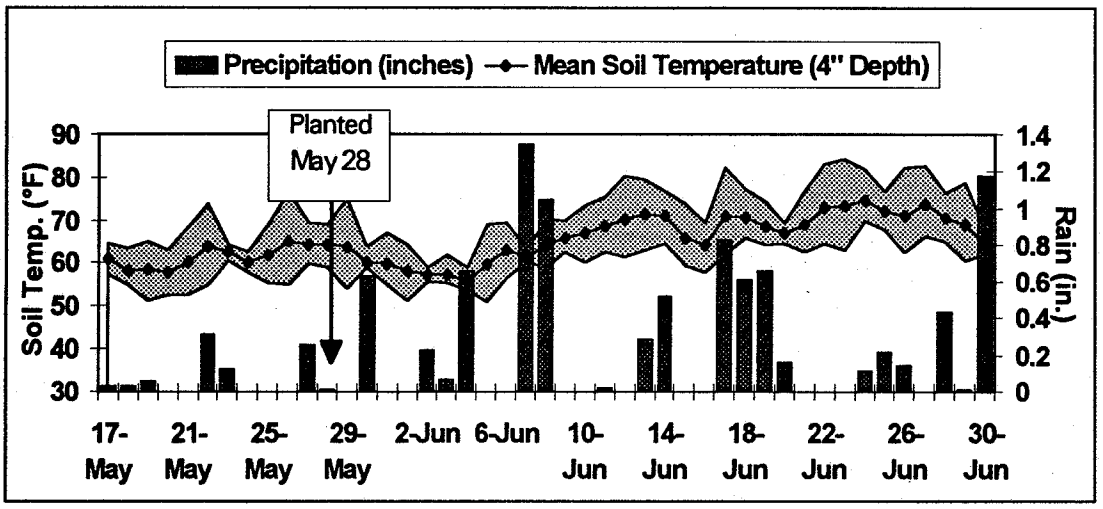

Fig. 12. Soil temperature and precipitation - Elkhorn (Palmyra), May-June, 1993.

Plant emergence and plant vigor were highest in plots planted with seedpieces cut and healed for 8 and 17 days before planting and in plots planted with untreated freshly cut seed. Seedpiece decay was variable between treatments and no clear-cut conclusions were drawn from the data. Seedpiece treatment had no significant impact on blackleg, Rhizoctonia stem infection, number of stems per plant, plant height or development of daughter tubers. Seedpiece treatments had no significant affect on yields.

Developing a Knowledge-Based Computer System to Predict and Avoid Seedpiece Decay Problems

Data collected during field and Biotron research over the last several years provides a wealth of information on the effects of different potato seedpiece handling procedures at planting. Perhaps as important as the effects of proper handling is information on the

consequences of improper handling. This information is proving useful in answering grower questions and refining seed handling recommendations. To begin to use this information for site specific recommendations, we have initiated the development of an expert system. The prototype system (WISH - Wisconsin Seedpiece Handling Program) has been developed using M.4, a knowledge system software tool. Grower comparisons showing predicted and actual stands are shown in Table 1. We will continue to test the prototype using data from our field trials and from grower fields and the expert system will be modified where necessary to accommodate new knowledge, personal experience and grower comments. If you would like to be part of the evaluation phase of this project, give us a call. The final expert system will be incorporated into future releases of the Potato Crop Management program.

Table 1. Grower Comparisons Using the Prototype Wisconsin Seedpiece Handling Program Including Predicted and Actual Stands

GROWER:	1				2				3	4	5	6		7	8	9	
Location:	A	B	C	D	A	B	C	D	A	A	A	A	B	A	A	A	B
potato_cultivar	NKH	NKH	NKH	RNL	RBK	ATL	RBK	RBK	ATL	RBK	RBK	NKH	RBK	RBK	RBK	NKH	RBK
tuber-temp at cutting (40,55,65)	50	53	64	52	61	55	50	52	55	43	47	52	47	50	47	47	50
soft rot at cutting	N	N	N	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N
fusarium rot at cutting (Y/N)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
fresh_cut	Y	Y	Y	Y	Y	N	N	N	N	N	Y	Y	Y	N	Y	N	N
healing (Y/N)	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y
healing time (days)	-	-	-	-	-	2	2	4	8	1	-	-	-	2	-	1	2
healing temp	-	-	-	-	-	55	55	55	55	50	-	-	-	55	-	55	55
fungicide seed treatment (Y/N)	Y-C	N	Y-C	Y-C	N	N	N	N	Y-T	Y-C	N	N	N	N	Y-C	N	N
soil type	LS	LS	LS	LS	LS	LS	LS	LS	SL	LS	LS	LS	LS	LS	LS	LS	LS
soil moisture at planting	MC	MC	S	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC	MC
soil temp at planting	44	51	65	50	68	50	52	65	60	48	47	45	50	47	45	45	50
soil moisture plant plus 4 day	MC	MC	S	MC	S	MC	MC	MC	MC	S	MC	MC	MC	MC	MC	MC	MC
soil temp plant plus 4 days	50	55	55	55	68	55	55	65	65	48	50	50	60	50	50	50	50
PREDICTED stand	100	100	50	75	69	100	100	100	100	100	100	100	100	100	100	100	100
ACTUAL stand	90	100	60	85	88	100	94	98	95	90	96	90	76	98	91.5	95	88

Key to Abbreviations

Cultivars: ATL = Atlantic, NKH = Russet Norkotah, RBK = Russet Burbank, RNL = Red Norland
Fungicide C = Captan, T = Topsin
Soil Type LS = Loamy Sand, SL = Silt Loam
Soil Moisture MC = Moisture Capacity S = Saturated