

THESIS

POTATO STORAGE STRESS PHYSIOLOGY AND DISEASE

Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

June, 1974

COLORADO STATE UNIVERSITY

June, 1974

WE HEREBY RECOMMEND THAT THE THESIS PREPARED  
UNDER OUR SUPERVISION BY EUGENE THOMAS KERSCHNER  
ENTITLED POTATO STORAGE STRESS PHYSIOLOGY AND DISEASE  
BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE  
DEGREE OF MASTER OF SCIENCE.

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## ABSTRACT OF THESIS

### POTATO STORAGE STRESS PHYSIOLOGY AND DISEASE

Russet Burbank and WC230-14 tubers were stored at 32 and 41<sup>o</sup>F in atmospheres of air, 4 or 8% CO<sub>2</sub> over a 175 day storage period. At approximately 6 week intervals, physiological and pathological measurements were made on tubers direct from storage and again following a 14 day reconditioning period (62<sup>o</sup>F and 95-100% relative humidity). Physiological measurements included free glucose, free fructose, and sucrose content, and cell membrane permeability. The rate of decay by Erwinia carotovora var. atroseptica (van Hall) Dye (soft rot bacterium) or Fusarium roseum var. sambucinum (LK.) Sn. & H. (dry rot fungus) represented the pathological components.

Compared to 41<sup>o</sup>F, storage at 32<sup>o</sup>F increased the sugar content, cell membrane permeability rate, and predisposed the tubers to disease. Increasing CO<sub>2</sub> during storage at 32 or 41<sup>o</sup>F increased each of the above parameters. Carbon dioxide effects became more pronounced as storage time increased. With increasing storage time, reducing sugar content usually leveled off in both varieties while sucrose, permeability, and disease susceptibility increased. WC230-14 tubers developed more reducing sugars during storage than Russet Burbank tubers and failed to eliminate the reducing sugars during reconditioning.

A linear regression analysis gave significant positive correlations between Erwinia decay and either cell membrane permeability or sucrose content. A multiple linear regression analysis combining cell membrane permeability and sucrose content accounted for 80% ( $R^2$ ) of the difference between storage treatments in rate of decay by Erwinia.

No significant correlations were obtained between the physiological parameters measured and Fusarium decay. Therefore, other factors not measured in this study must contribute to decay by this fungus.

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## ACKNOWLEDGMENTS

A special thanks to my adviser, Dr. Milton Workman, for his guidance and direction during my program. Thanks also to Dr. Monty Harrison and Dr. Ken Knutson for their assistance as members of my advisory committee.

My thanks to Dr. Monty Harrison for supplying the Fusarium and Erwinia cultures.

Also I thank my wife, Karen, for her support and encouragement throughout my program.

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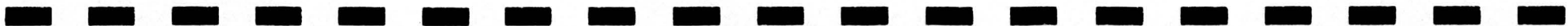
## I. INTRODUCTION

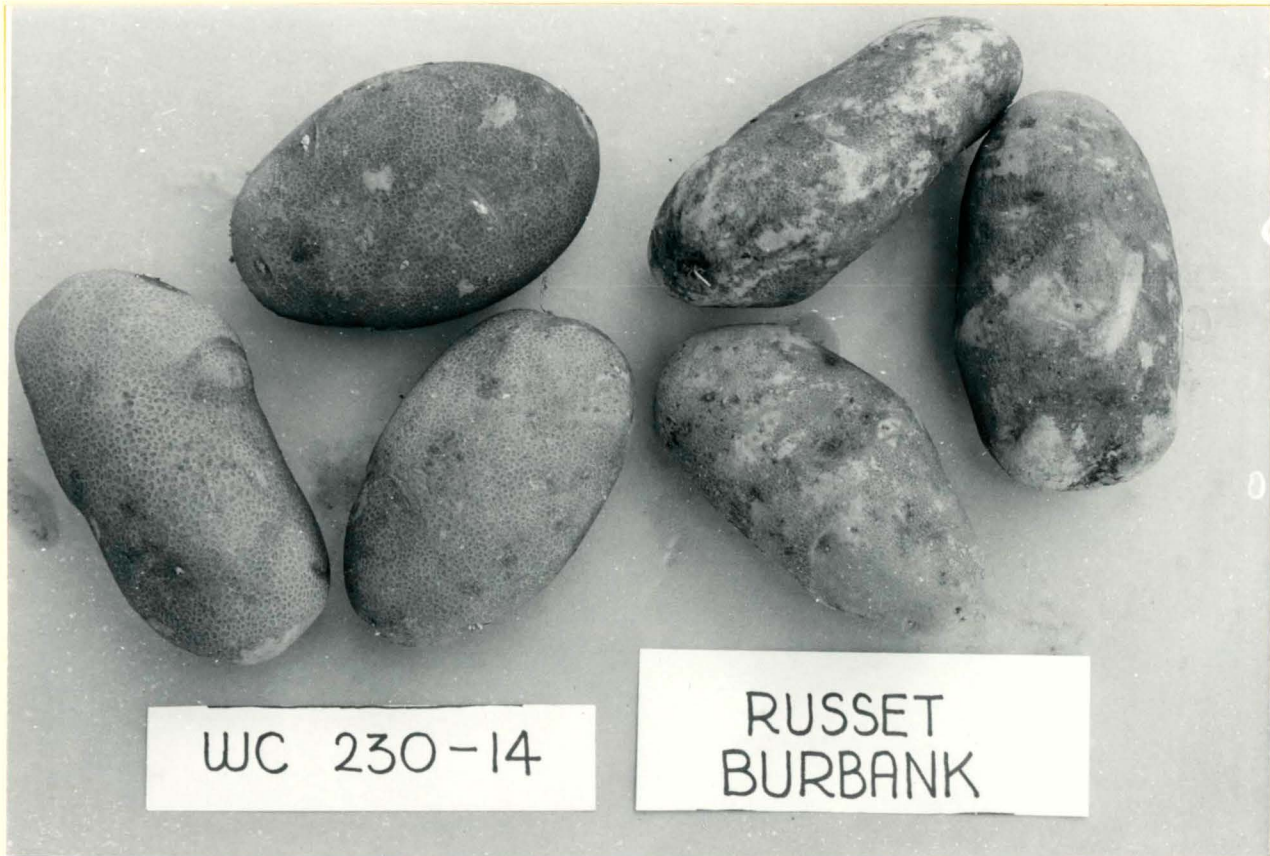
Promising seedling potatoes selected in a varietal development program must be evaluated through a screening procedure which will uncover undesirable as well as desirable characteristics. This study was undertaken to develop procedures to identify possible physiological and/or pathological weaknesses during tuber storage whether for seed, processing, or fresh market use.

In this study, a promising Russet selection presently identified as WC230-14 was compared with a proven standard variety (Russet Burbank) throughout a 175 day storage period. WC230-14 has excellent tuber type (Fig. 1), produces good yields and has other desirable characteristics. However, poor stands have occasionally been observed.

A range of stress conditions was used during storage to identify potential weaknesses between varieties. The stress conditions were accomplished through the use of different temperatures and levels of CO<sub>2</sub> (17, 18). At regular intervals throughout the storage period, tubers were removed from their respective treatments and analyzed for possible differences in cell membrane permeability, sugars, and decay by two common storage pathogens, Fusarium roseum var. sambucinum (L.K.) Sn. & H. (dry rot fungus) and Erwinia carotovora var. atroseptica (van Hall) Dye (soft rot bacterium). After inoculation,

Figure 1. General appearance of Russet Burbank and  
WC230-14 tubers.





WC 230-14

RUSSET  
BURBANK

the tubers were incubated at 62°F and 95-100% relative humidity for a specified length of time and the extent of decay was determined. At the same time that tubers were evaluated directly from storage, other non-inoculated tubers were reconditioned at 62°F and 95-100% relative humidity for 14 days. The reconditioned tubers were then evaluated with respect to cell membrane permeability, sugars, and decay in the same manner as tubers taken directly from storage. Reconditioning served to determine whether changes in sugar content and membrane permeability could be related to disease susceptibility (16).

## II. LITERATURE REVIEW

Storage conditions have been shown to affect the accumulation of sugars in potato tubers. Harkett (8) stored potatoes at 1°C for 30 days in various levels of O<sub>2</sub> from 0 to 100% and observed that O<sub>2</sub> concentrations below 3% prevented the accumulation of both sucrose and reducing sugars. In O<sub>2</sub> concentrations above 3%, sucrose increased during the first 21 days then either dropped or remained steady depending on the O<sub>2</sub> concentration. The greatest accumulation of sucrose occurred in air after 21 days. The largest accumulation of reducing sugars occurred in air and 40% O<sub>2</sub> at the end of the 30 day period. Workman and Twomey (18) observed a lower accumulation of reducing sugars with a decrease in the O<sub>2</sub> concentration (2, 5 and 21%) during 5 months at 32 and 41°F. Increasing the CO<sub>2</sub> from 0 to 4% increased reducing sugars at 41°F but not at 32°F. Also, 32°F storage resulted in higher reducing sugar content than 41°F.

Burton (5) stored tubers at 2, 4, 6, 10 and 15°C and reported an increase in total sugars and reducing sugars during a 4 week storage period with decreasing temperature. Reconditioning of tubers previously stored at 4°C was virtually complete after three weeks at 20°C.

The cell membrane permeability of potato tubers has also been influenced by the storage environment. Craft (6) reported that permeability (electrolyte leakage) was several fold higher following 0°C

storage than following 12.8°C storage for 2 months. Workman and Twomey (17) stored potatoes in air, 4, 8 and 12% CO<sub>2</sub> and showed an increase in permeability of Russet Burbank potato tissue at 5°C with an increase in the CO<sub>2</sub> level. This was not observed at 0°C until after 145 days of a 185 day storage period. Permeability also decreased with storage time at 5°C but increased at 0°C. Storage at 0°C increased permeability several fold above 5°C storage. Workman and Twomey (18) found that decreasing the O<sub>2</sub> concentration from 21% to 5 or 2% during storage at 32°F decreased permeability of Kennebec potato tissue. The same effect was not observed at 41°F. No significant differences in permeability between storage in 0 and 4% CO<sub>2</sub> occurred at either 32 or 41°F over a 5 month storage period.

Tuber disease susceptibility can also be influenced by the storage environment. Nielsen (14) found that three Erwinia species (E. atroseptica, E. carotovora, and E. aroideae) decayed freshly injured tuber tissue 4-10 times more rapidly in a 20 : 80 CO<sub>2</sub> - N atmosphere than in air. The incubation period was 48 hours at 24°C. However, whether the CO<sub>2</sub> - N atmosphere benefited the pathogens or only pre-disposed the potato tissue was not clarified. Also, since O<sub>2</sub> was excluded the response could have been an anaerobic one and not due to CO<sub>2</sub> alone. Nielsen (15) found that the incidence of bacterial soft rot increased with the depletion of O<sub>2</sub> and increase in CO<sub>2</sub> in sealed containers. With higher potato temperatures, a rapid depletion of O<sub>2</sub> and increase in CO<sub>2</sub> occurred and soft rot developed more rapidly

than when potato temperatures were lower. Lund and Nicholls (11), and Lund and Wyatt (12) reported that soft rot of potato tubers was greatly increased by replacing air with  $N_2$  at 10 or 20°C and 100% relative humidity. Cromarty and Easton (7) found that keeping tubers dry entirely prevented soft rot development during simulated transit periods of 8 days at 70°F or 11 days at 60, 50 or 40°F. In another experiment they found that the longer the tubers were incubated at 70°F in wet conditions prior to a simulated transit period of 8 days at 70, 60, 50 or 40°F, the more bacterial soft rot developed. In both experiments, a low (2-4%) and a high (20.5%)  $O_2$  level were compared during the simulated transit period. More soft rot occurred under low  $O_2$  at each temperature and with higher simulated transit temperature.

Lipton (10) reported that Fusarium surface growth, during 8 day simulated transit periods at 59 and 68°F, was greater under 1/2 or 1%  $O_2$  than under 5 or 21%  $O_2$ . Similar results were not observed at 41°F storage. Workman and Twomey (18) observed that increasing  $CO_2$  over the range of 0, 4, 8 and 12% in combination with air, 2 or 5%  $O_2$ , accelerated tuber decay by unidentified Fusarium species over a 5 month storage period at 32 or 41°F. Alvarado E. and Guzman N. (2) found that F. roseum and F. oxysporum decay was proportional to increasing storage temperature in the range of 40, 59, 66, and 84°F. The time in storage was not reported. Boyd (4) inoculated tubers with F. caeruleum after various storage periods and temperatures.

He found that the % tuber infection following inoculation and 6 weeks incubation at 60<sup>o</sup>F increased with tuber age and increasing storage temperature. Resistance of potato tubers to Fusarium dry rot has been shown to vary with variety (3, 4, 2).

Little is known about the substrate requirements for Erwinia and Fusarium species. However, Lund and Wyatt (13) have shown that E. carotovora var. atroseptica is capable of converting sucrose into reducing substances.

Nielsen and Todd (16) studied the relationship between soft rot by unknown bacterial species and sugar concentration or the sugar diffusion rate from tissue sections into distilled water. Tubers were stored at 4, 13, 22, 30 and 40<sup>o</sup>C for 10 or 20 days. The highest sugar concentrations (reducing and total) occurred at 4 and 40<sup>o</sup>C storage. These values were also equal. However, only tissue slices taken from tubers stored at 40<sup>o</sup>C decayed following inoculation. Exposing tubers previously stored for 10 days at the above temperatures to 47<sup>o</sup>C for 60 minutes rendered all of them susceptible to soft rot decay but did not change the sugar concentration. However in another experiment, Nielsen and Todd discovered that exposure to sublethal temperatures in most cases increased the rate of sugar diffusion from tissue sections and this appeared to be related to the degree of soft rot.

Most of the above studies were of relatively short duration. Also, the effect of storage environment on the potato tissue was not always differentiated from the effect on the pathogen. With the exception of

Nielsen and Todd (16), no studies were found that correlated physiological changes with Erwinia or Fusarium decay. The following study was designed to obtain information in each of the above areas.

### III. MATERIALS AND METHODS

#### General

Russet Burbank and WC230-14 tubers, grown during 1972 in the San Luis Valley, were used in all experiments. The average tuber weight was 6.4 ounces for Russet Burbank and 6.9 ounces for WC230-14.

Tubers of each variety were randomly sorted and placed into air tight containers (Fig. 2). Approximately 75 tubers of each variety were placed in each container. The containers were equipped with an inlet and outlet to permit continuous ventilation with either air, 4 or 8% CO<sub>2</sub>.

Two storage temperatures, 32 and 41<sup>o</sup>F, were used. Temperature fluctuation was  $\pm$  1.0<sup>o</sup>F. The relative humidity in the containers was kept above 95% to minimize weight loss.

Carbon dioxide and air were mixed using a flow board equipped with capillary tubes to obtain the desired atmosphere (Fig. 2). The ventilation rates were 12 liters per hour in the 4 and 8% CO<sub>2</sub> treatments and 19 liters per hour in the air treatment. The increased flow rate in the air treatment insured rapid removal of respiratory CO<sub>2</sub>. Four containers per treatment were connected in series (Fig. 2). The Russet Burbank Cultivar was placed in containers labeled 'A' and

Figure 2. Flow board with capillaries for mixing CO<sub>2</sub> and air to obtain the desired atmospheres, and the storage containers. The direction of flow was A → B → C → D.



'C' and WC230-14 in containers labeled 'B' and 'D' (Fig. 2). The direction of ventilation through the four containers was reversed each week to insure exposure of both varieties to comparable atmospheres in respect to volatiles.

The CO<sub>2</sub> concentrations were monitored every two or three weeks using a Burrell gas analysis apparatus (Orsatt-type, Model #39-507). Throughout the 175 day storage period, the 4% CO<sub>2</sub> treatment averaged  $4.0 \pm 0.4\%$  and the 8% CO<sub>2</sub> treatment averaged  $8.0 \pm 0.7\%$ . The air treatment remained below 0.2% CO<sub>2</sub>.

Initial physiological and pathological comparisons of the two varieties were made just prior to storage on November 2, 1972. The following measurements were made: cell membrane permeability, free glucose, free fructose, sucrose and total sugar content, and the relative rate of decay by Erwinia carotovora var. atroseptica (van Hall) Dye and Fusarium roseum var. sambucinum (LK.) Sn. & H. The same measurements were made on tubers removed from the various treatments four times (after approximately 6, 12, 18 and 24 weeks) during the storage season. The procedures are described below.

#### Cell Membrane Permeability

Two cores, 9 mm. in diameter and running the length of the tuber within the vascular rings, were removed with a #4 cork borer. Twenty-five discs, 3 mm. thick, were selected at random from a large

number of discs cut from the cores. For the initial measurements, four tubers were used per variety and each tuber was considered a replication. During the storage season, discs from three tubers per treatment were composited and 25 discs selected at random constituted one replication. Two replications were run on each treatment.

The discs were rinsed thoroughly in distilled water, drained and suspended in 200 ml. of distilled water contained in 250 ml. erlenmeyer flasks. The increase in conductivity of the distilled water, measured in micromhos with an Industrial Instrument Conductivity Bridge Model RC16B2, was used to determine rate of ion loss. An initial reading and four more readings spaced 25 minutes apart established the rate of ion leakage. The flasks were shaken one minute prior to each reading. The readings were entered into a two variable linear regression program in a model 9810A Hewlett Packard computer to determine the average rate of ion leakage per hour. Differences in the rate of ion leakage were considered representative of changes in cell membrane permeability.

#### Erwinia Inoculation and Evaluation of Decay

An isolate of Erwinia carotovora var. atroseptica (van Hall) Dye was obtained from Dr. Monty Harrison of the Botany and Plant Pathology Department. The same isolate was used in prior studies (1). Transfers made onto veal infusion (V.I.) agar slants were placed at room temperature for 24 hours and then stored at approximately 50° F.

Transfers for inoculum increase were made to fresh V.I. slants from these stock slants. The inoculum slants were incubated at room temperature for 24 hours. Sterile distilled water was added to each test tube and the bacteria were suspended in the water with a Van Waters and Rogers "Vari-Whirl" Mixer. The suspension from three tubes was consolidated. The inoculum density was adjusted with additions of sterile distilled water to an absorbance reading of 1 using 1 inch colorimetric tubes with a 'Spectronic 20' colorimeter set at 420 mu. The colorimeter was set at 100% transmission with distilled water. An absorbance of 1 corresponds to a concentration of approximately  $2.88 \times 10^8$  bacteria per cc. (1).

Pathogenicity of the bacterium was tested within two days prior to the inoculations using the following procedure. The stem of a young Norgold potato plant was inoculated by needle puncture with bacteria just below a node using aseptic techniques. The plant was placed in a closed jar for 24 to 48 hours at 22-25°C and 100% relative humidity. The development of a brown or black soft rot lesion indicated that the bacteria were pathogenic. Plants inoculated with a sterile needle served as controls.

After the pathogenicity of the bacteria was verified, 0.01 ml. of the suspension (containing  $2.88 \times 10^6$  bacteria) was inoculated to a depth of 2.5 cm. into each tuber at two locations. One inoculation was placed 1/3 of the length of the tuber from the bud end and the second a comparable distance from the stolon end. The needle was

flamed between treatment groups. The eye end of a large needle was used to make the inoculations (Fig. 3). The tubers were sterilized with 1% hypochloride for 3-5 minutes before inoculation.

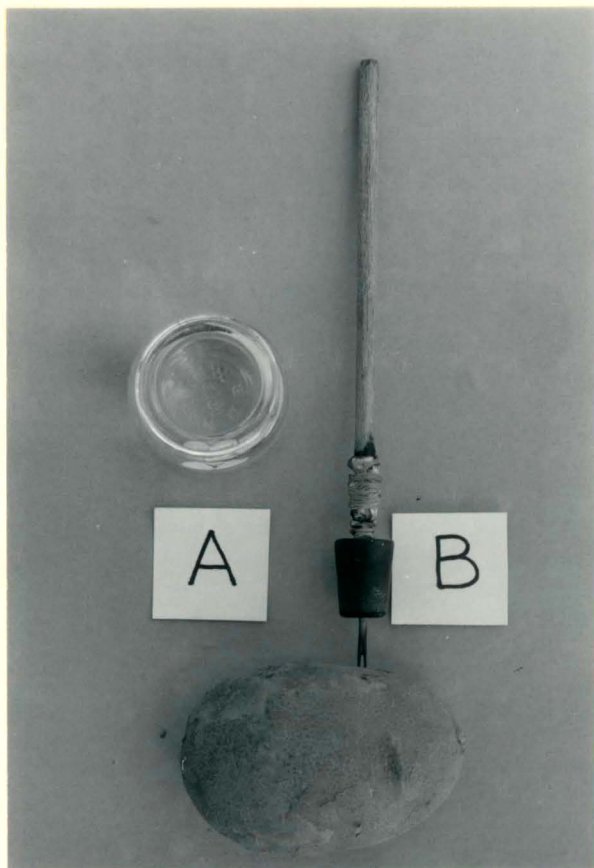
For initial comparison of the two varieties, 10 tubers of each were inoculated as above. During the storage season, 5 tubers of each treatment were inoculated and each tuber was considered a replication. The inoculated tubers were incubated at 62° F and 95-100% relative humidity. After exactly four days, the amount of decay was measured. The rotted tissue was removed with a spatula and using a buret the volume of distilled water required to fill the resulting cavity was determined.

#### Fusarium Inoculation and Evaluation of Decay

Isolates of Fusarium roseum var. sambucinum (L.K.) Sn. & H. were obtained from Dr. Monty Harrison of the Department of Botany and Plant Pathology. Three slants were prepared four days before the intended inoculation time. Spore suspensions were obtained by adding distilled water to the tubes and shaking with a Van Waters and Rogers "Vari-Whirl" Mixer. Three suspensions were combined and the spore count determined using a Hemacytometer (blood cell counter) and adding sterile water to obtain the desired concentration. The concentration was adjusted to  $2.80 \times 10^6$  spores per cc.

Potato tubers were washed, cut in half lengthwise and sterilized in 1% hypochloride for 3-5 minutes. They were then rinsed with

Figure 3. Erwinia inoculation procedure:  
A) inoculum B) inoculating needle.



distilled water and placed in paper covered trays to dry. Two holes, 5 mm. deep and 10 mm. diameter, were cut into the tubers at locations with a specially adapted #5 cork borer (Fig. 4). One hole was 1/3 the tuber length from the stem end and the other a similar distance from the bud end. A dropping pipette delivering 0.02 cc. per drop was used to place one drop in each hole. One drop contained  $5.60 \times 10^4$  spores.

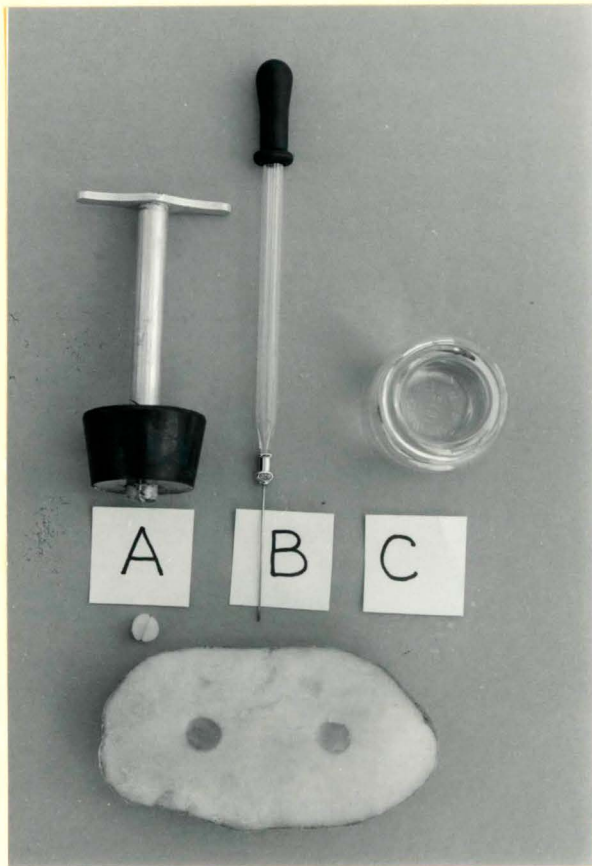
Initial readings of Fusarium decay were made at the start of the storage season on ten tubers per variety. Thus there were twenty tuber halves per variety. Readings during the storage season were obtained by using five tubers per treatment (10 halves) for inoculation. After inoculation, the tubers were incubated at 62° F and 95-100% relative humidity for 7 days. The rotted tissue was removed with a spatula and the volume of the resulting cavity determined as described for Erwinia decay. The volume was used as a measure of decay.

### Sugar Determinations

#### Sample Preparation

The tubers were cut longitudinally to obtain sections about 1 cm. thick. The sections were diced and a random 25 g. sample was selected. The sample was blended for one minute in a Waring Blender with 125 ml. of 95% ethanol. The 25 g. sample plus 125 ml. of 95% ethanol gave a final ethanol concentration of approximately 80%. The contents were sealed in one pint jars and stored at 41° F until analyzed.

Figure 4. Fusarium inoculation procedure:  
A) cavity tool B) inoculating drop  
dispenser C) inoculum.



The samples were filtered through Whatman #1 filter paper and the volume adjusted to 150 ml. with 80% ethanol.

One tuber per replication and four replications per variety were used for the initial analysis. Values obtained throughout the storage season were obtained using composites of three tubers per replication and two replications per treatment. Essentially Method II of Johnson et al. (9) was used for all sugar analysis. A brief description of each method with modifications is given below.

#### Free Glucose Analysis

A one ml. aliquot of the sample, 3.9 ml. of distilled water and 5 ml. of glucose oxidase solution were mixed in a test tube. After a reaction time of 10 minutes at room temperature, 0.1 ml. of 4 N HCL was added to stop the reaction. The solution was transferred to 3/4 inch colorimetric tubes and the absorbance determined on a 'Spectronic 20' colorimeter at 400 mu. A blank containing 1 ml. of 80% ethanol was used to set the colorimeter to 100% transmission. Three samples containing 100 ug. per ml. of free glucose were used as standards for each analysis. Occasionally samples were diluted with 80% ethanol to reduce the concentration of free glucose to the 50-150 ug. per ml. range.

The % free glucose on a fresh weight basis was calculated as follows:

$$\% \text{ free glucose} = \left( \frac{\text{abs.} - \text{aliquot}}{\text{abs.} - \text{standard}} \right) \left( \frac{100 \text{ ug.}}{\text{ml.}} \right) \left( \frac{150 \text{ ml.}}{25 \times 10^6 \text{ ug.}} \right) (100)$$

#### Total Fructose Analysis

The colorimetric procedure, using anthrone reagent, required that the fructose concentration in the extract be within the range of 25 to 100 ug. per ml. Samples having more than 100 ug. per ml. were diluted with 80% ethanol to bring the concentration within the permissible range.

Ten ml. of the anthrone reagent (9) was added to 1 ml. of the undiluted or properly diluted sample and placed in ice water until run. After all samples in a given run were prepared, the tubes were placed in 122° F water for 20 minutes and cooled immediately for 2 minutes in an ice bath. After transfer to 3/4 inch colorimetric tubes, the optical density of each sample was read at 620 mu. using a 'Spectronic 20' colorimeter. A reagent blank with 1 ml. of 80% ethanol was used to set the colorimeter to 100% transmittance. The average absorbance of three 50 ug. fructose standards was used to calculate the fructose concentration in the unknowns. The procedure is shown below.

$$\% \text{ total fructose} = \left( \frac{\text{abs.} - \text{aliquot}}{\text{abs.} - \text{standard}} \right) \left( \frac{50 \text{ ug.}}{\text{ml.}} \right) \left( \frac{150 \text{ ml.}}{25 \times 10^6 \text{ ug.}} \right) (100)$$

#### Total Sugar Analysis

The procedure was the same as for total fructose with the exception that the reaction was carried out in boiling water (95°C) for

15 minutes. The average absorbance of three 50 ug. per ml. sucrose standards were used to calculate the total sugar concentration in the unknowns. Calculations were the same as shown above for % total fructose except the absorbance of the sucrose standard was used instead of fructose.

#### Calculations for Free Fructose and Sucrose

Free glucose, total fructose and total sugars were obtained directly by analysis. Free fructose and sucrose were determined by calculation as shown below:

$$\% \text{ total glucose} = \% \text{ total sugar} - \% \text{ total fructose}$$

$$\% \text{ bound glucose in sucrose} = \% \text{ total glucose} - \% \text{ free glucose}$$

$$\% \text{ sucrose} = \% \text{ bound glucose in sucrose} \times \frac{342.2 \text{ (mol. wt. of sucrose)}}{180.2 \text{ (mol. wt. of glucose)}}$$

$$\% \text{ free fructose} = \% \text{ total fructose} - \% \text{ bound fructose (glucose) in sucrose}$$

#### IV. RESULTS

Initial observations, 6 weeks after harvest and prior to storage, showed that Russet Burbank and WC230-14 tubers were similar with respect to cell membrane permeability and the content of sucrose, free glucose, free fructose, and total sugars (Table 1). However, Russet Burbank was significantly more resistant to decay by Erwinia than WC230-14. The reverse was true for Fusarium decay.

In order to more clearly present the data taken during the approximately 6 month storage period, the following format was used. Each variable such as permeability, sugars, Erwinia decay, etc. was considered separately in relationship to levels of CO<sub>2</sub>, variety, and storage temperature. Within each variable the results obtained directly from storage will be discussed first and then the results following the reconditioning period.

##### Cell Membrane Permeability - Direct from Storage (Table 2)

##### Carbon Dioxide Effects

48 days - Cell membrane permeability of Russet Burbank stored at 41 or 32°F was not consistently increased or decreased by the storage CO<sub>2</sub> level. Storing WC230-14 in 4% CO<sub>2</sub> at 41°F significantly increased permeability, but permeability following storage in 8% CO<sub>2</sub> was not significantly different from either air or 4% CO<sub>2</sub>. At 32°F,

Table 1. Initial physiological and pathological measurements taken November 2, 1972 before placing the potatoes in storage.

	<u>Russet Burbank</u>	<u>WC230-14</u>	<u>Signi- ficance</u>
Permeability (micromhos/hr.)	18.6	22.3	NS
Free Glucose (% F. W. B.)	0.02	0.02	NS
Free Fructose ( " )	0.01	0.00	NS
Sucrose ( " )	0.10	0.13	NS
Total Sugars ( " )	0.13	0.15	NS
<u>Erwinia</u> decay (cc. per inoculation)	1.4	1.9	1%
<u>Fusarium</u> decay (cc. per inoculation)	1.9	1.0	1%

Table 2. The influence of storage time, temperature, atmosphere, and reconditioning on the permeability of potato tissue sections. Values shown are in micromhos per hour increase in conductivity.

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	59 <sup>g<sup>2/</sup></sup>	41 <sup>g</sup>	31	106 <sup>g</sup>	37 <sup>e</sup>	65	45 <sup>g</sup>	36 <sup>f</sup>	20	75 <sup>d</sup>	35 <sup>e</sup>	53	71	37	42
		4%	84 <sup>fg</sup>	55 <sup>efg</sup>	35	115 <sup>g</sup>	41 <sup>de</sup>	64	63 <sup>g</sup>	31 <sup>f</sup>	51	82 <sup>d</sup>	52 <sup>e</sup>	37	86	45	47
		8%	112 <sup>efg</sup>	46 <sup>fg</sup>	59	164 <sup>fg</sup>	72 <sup>cde</sup>	65	80 <sup>fg</sup>	40 <sup>f</sup>	50	108 <sup>cd</sup>	47 <sup>e</sup>	56	116	48	58
41°	WC230-14	Air	84 <sup>fg</sup>	69 <sup>cde</sup>	18	167 <sup>fg</sup>	54 <sup>cde</sup>	68	101 <sup>efg</sup>	51 <sup>ef</sup>	50	137 <sup>cd</sup>	44 <sup>e</sup>	68	122	55	51
		4%	191 <sup>bcd</sup>	61 <sup>defg</sup>	68	242 <sup>e</sup>	63 <sup>cde</sup>	74	162 <sup>def</sup>	55 <sup>def</sup>	66	158 <sup>c</sup>	41 <sup>e</sup>	74	188	55	71
		8%	150 <sup>def</sup>	76 <sup>cd</sup>	49	238 <sup>e</sup>	78 <sup>bcd</sup>	67	213 <sup>cd</sup>	86 <sup>c</sup>	60	247 <sup>b</sup>	82 <sup>d</sup>	67	212	81	61
32°	R. Burbank	Air	159 <sup>def</sup>	42 <sup>g</sup>	74	319 <sup>d</sup>	47 <sup>de</sup>	85	188 <sup>cde</sup>	41 <sup>f</sup>	78	264 <sup>b</sup>	46 <sup>e</sup>	83	233	44	80
		4%	171 <sup>cde</sup>	53 <sup>efg</sup>	69	282 <sup>de</sup>	86 <sup>abc</sup>	70	206 <sup>cd</sup>	76 <sup>cde</sup>	63	251 <sup>b</sup>	85 <sup>d</sup>	66	228	75	67
		8%	146 <sup>def</sup>	65 <sup>def</sup>	55	232 <sup>ef</sup>	110 <sup>ab</sup>	53	225 <sup>cd</sup>	124 <sup>a</sup>	45	295 <sup>b</sup>	155 <sup>b</sup>	47	224	114	50
32°	WC230-14	Air	261 <sup>b</sup>	86 <sup>bc</sup>	67	438 <sup>bc</sup>	76 <sup>bcd</sup>	83	275 <sup>bc</sup>	81 <sup>cd</sup>	71	541 <sup>a</sup>	85 <sup>d</sup>	84	379	82	76
		4%	245 <sup>bc</sup>	103 <sup>ab</sup>	58	459 <sup>ab</sup>	86 <sup>abc</sup>	81	360 <sup>b</sup>	95 <sup>bc</sup>	74	574 <sup>a</sup>	131 <sup>bc</sup>	77	410	104	73
		8%	357 <sup>a</sup>	120 <sup>a</sup>	66	512 <sup>a</sup>	118 <sup>a</sup>	77	518 <sup>a</sup>	115 <sup>ab</sup>	78	604 <sup>a</sup>	218 <sup>a</sup>	64	498	143	71

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62°F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

WC230-14 permeability significantly increased under 8% CO<sub>2</sub> but 4% CO<sub>2</sub> was not significantly different from air.

95 + 134 + 175 days - With one exception, increasing CO<sub>2</sub> increased the tissue permeability of both varieties. Russet Burbank stored at 32° F for 95 days decreased in permeability with increasing CO<sub>2</sub>.

Summary of CO<sub>2</sub> Effects - Although the increases in permeability with increasing CO<sub>2</sub> relative to air were not always significant, a consistent increase at both temperatures was shown by both varieties. In almost every comparison, storage in 8% CO<sub>2</sub> increased permeability more than storage in 4% CO<sub>2</sub>.

#### Variety Comparison

WC230-14 always exhibited higher permeability than Russet Burbank under comparable storage temperatures and atmospheres. The differences were significant except for tubers stored in air or 8% CO<sub>2</sub> at 41° F and 4% CO<sub>2</sub> at 32° F for 48 days, and in air at 32° F for 134 days. Increasing the CO<sub>2</sub> usually accentuated the permeability differences between varieties.

#### Storage Temperature Effects

Storage at 32° F resulted in higher permeability than 41° F storage and both varieties responded similarly. In most cases the differences were significant. Non-significant differences occurred

only when Russet Burbank was stored 48 or 95 days in 8% CO<sub>2</sub>, and when WC230-14 was stored 48 days in 4% CO<sub>2</sub>.

#### Cell Membrane Permeability - Following Reconditioning (Table 2)

##### Carbon Dioxide Effects

The CO<sub>2</sub> induced increase in permeability observed following 41° F storage was either eliminated or reduced during reconditioning. However, in most comparisons tubers of both varieties previously stored in 4 or 8% CO<sub>2</sub> at 41° F still retained higher permeability after reconditioning than those stored in air.

The CO<sub>2</sub> effect on permeability observed at 32° F was somewhat diminished by reconditioning, but significant levels above air storage still existed.

##### Variety Comparison

In all comparisons, WC230-14 retained higher permeability after reconditioning than Russet Burbank. In most cases the differences were significant. However, the % reduction in permeability rates after reconditioning was higher for WC230-14.

##### Storage Temperature Effects

In most comparisons, tubers of both varieties stored at 32° F retained higher permeability rates than those stored at 41° F. The effect of previous storage on reconditioning gained significance as

time in storage increased. Also the % reduction due to reconditioning was higher for tubers previously stored at 32°F than 41°F.

Erwinia Decay - Direct from Storage (Table 3)

Carbon Dioxide Effects

48 days - The rate of decay for either variety was not significantly changed by the level of CO<sub>2</sub> during storage at 41°F. However at 32°F, the rate of decay of both varieties stored in 8% CO<sub>2</sub> was significantly more rapid than for tubers stored in air. The rate of decay of both varieties stored in 4% CO<sub>2</sub> at 32°F was intermediate between the rates in air or 8% CO<sub>2</sub>.

95 days - No significant differences in the rate of decay due to the level of CO<sub>2</sub> occurred during 32 or 41°F storage. However, the rate of decay of Russet Burbank stored at 32°F consistently increased with an increase in CO<sub>2</sub>.

134 days - The rate of decay of both varieties was significantly higher when stored at 41°F in 8% CO<sub>2</sub> than when stored in air. Storage in 4% CO<sub>2</sub> at 41°F also increased the rate of decay but this was not significantly different from tubers stored in air. At 32°F, the rate of decay of both varieties was significantly higher when stored in 8% CO<sub>2</sub> than when stored in air. Rate of decay of Russet Burbank was also significantly more rapid following storage in 8% CO<sub>2</sub> than when stored in 4% CO<sub>2</sub>.

Table 3. The influence of storage time, temperature, atmosphere, and reconditioning on the decay of potato tissue by *Erwinia*. Values shown are volume of tissue destroyed (cc. per inoculation).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	1.9 <sup>bcd</sup> <sup>2/</sup>	1.8 <sup>ab</sup>	5	1.9	1.4 <sup>c</sup>	26	1.4 <sup>d</sup>	1.7 <sup>a</sup>	0	1.9 <sup>d</sup>	1.4 <sup>d</sup>	26	1.8	1.6	14
		4%	1.7 <sup>bcd</sup>	1.6 <sup>abcde</sup>	6	1.8	1.6 <sup>ab</sup>	11	1.6 <sup>bcd</sup>	1.6 <sup>ab</sup>	0	1.8 <sup>d</sup>	1.6 <sup>bcd</sup>	11	1.7	1.6	7
		8%	1.6 <sup>cd</sup>	1.6 <sup>abcde</sup>	0	1.7	1.7 <sup>ab</sup>	0	1.8 <sup>abc</sup>	1.6 <sup>ab</sup>	11	2.2 <sup>cd</sup>	1.7 <sup>abc</sup>	23	1.8	1.7	9
41°	WC230-14	Air	1.6 <sup>cd</sup>	1.8 <sup>ab</sup>	0	1.9	1.8 <sup>a</sup>	5	1.4 <sup>d</sup>	1.7 <sup>a</sup>	0	1.8 <sup>d</sup>	1.6 <sup>bcd</sup>	11	1.7	1.7	4
		4%	1.6 <sup>cd</sup>	1.8 <sup>ab</sup>	0	1.9	1.8 <sup>a</sup>	5	1.5 <sup>cd</sup>	1.5 <sup>ab</sup>	0	2.1 <sup>d</sup>	1.6 <sup>bcd</sup>	24	1.8	1.7	7
		8%	1.5 <sup>d</sup>	1.7 <sup>abcd</sup>	0	1.9	1.8 <sup>a</sup>	5	1.7 <sup>bc</sup>	1.4 <sup>b</sup>	18	3.0 <sup>b</sup>	1.9 <sup>a</sup>	37	2.0	1.7	15
32°	R. Burbank	Air	1.6 <sup>cd</sup>	1.7 <sup>abcd</sup>	0	1.7	1.6 <sup>ab</sup>	6	1.3 <sup>d</sup>	1.6 <sup>ab</sup>	0	2.9 <sup>b</sup>	1.5 <sup>bcd</sup>	48	1.9	1.6	14
		4%	1.7 <sup>bcd</sup>	1.7 <sup>abcd</sup>	0	1.9	1.6 <sup>ab</sup>	16	1.5 <sup>cd</sup>	1.5 <sup>ab</sup>	0	2.8 <sup>bc</sup>	1.4 <sup>d</sup>	50	2.0	1.6	17
		8%	2.0 <sup>b</sup>	1.7 <sup>abcd</sup>	15	2.3	1.7 <sup>ab</sup>	26	2.1 <sup>a</sup>	1.5 <sup>ab</sup>	29	3.2 <sup>a</sup>	1.7 <sup>abc</sup>	47	2.4	1.7	29
32°	WC230-14	Air	1.6 <sup>cd</sup>	1.6 <sup>abcde</sup>	0	1.7	1.5 <sup>bc</sup>	12	1.4 <sup>d</sup>	1.4 <sup>b</sup>	0	2.8 <sup>bc</sup>	1.4 <sup>d</sup>	50	1.9	1.5	16
		4%	1.9 <sup>bcd</sup>	1.5 <sup>de</sup>	21	1.7	1.5 <sup>bc</sup>	12	1.6 <sup>bcd</sup>	1.5 <sup>ab</sup>	6	3.7 <sup>a</sup>	1.5 <sup>bcd</sup>	59	2.2	1.5	25
		8%	2.3 <sup>a</sup>	1.4 <sup>e</sup>	39	1.7	1.4 <sup>c</sup>	18	1.9 <sup>ab</sup>	1.6 <sup>ab</sup>	16	3.6 <sup>a</sup>	1.7 <sup>abc</sup>	53	2.4	1.5	32

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62°F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

175 days - No significant effects of CO<sub>2</sub> on the rate of decay of Russet Burbank during storage at 41° F were observed. However, storage of WC230-14 in 8% CO<sub>2</sub> at 41° F significantly increased the rate of decay over that following storage in air or 4% CO<sub>2</sub>. A significant increase in the rate of decay of Russet Burbank followed storage in 8% CO<sub>2</sub> at 32° F relative to the rate following storage in air or 4% CO<sub>2</sub>. Both 4 and 8% CO<sub>2</sub> at 32° F significantly increased the rate of decay of WC230-14 relative to the rate following storage in air.

Summary of CO<sub>2</sub> Effects - Increasing the level of CO<sub>2</sub> during storage increased the rate of decay of both varieties. This was observed during all evaluations except one (WC230-14 after 95 days) from 32° F storage and during the last two evaluations (134 and 175 days) from 41° F storage.

#### Variety Comparison

No significant differences existed between the two varieties in the rate of decay when compared after 48, 95 and 134 days of storage at either 32 or 41° F. After 175 days, WC230-14 decayed significantly more rapidly than Russet Burbank when both had been stored at 41° F in 8% CO<sub>2</sub>. The same result occurred when both varieties had been stored at 32° F in 4% CO<sub>2</sub>.

#### Storage Temperature Effects

48 days - Both varieties previously stored in 8% CO<sub>2</sub> at 32° F decayed significantly faster than when stored in 8% CO<sub>2</sub> at 41° F.

95 + 134 days - The analysis of variance showed a non-significant F test at the 5% level.

175 days - In all comparisons tubers of both varieties previously stored at 32°F decayed more rapidly than those previously stored at 41°F.

Summary of Storage Temperature Effects - Storage at 32°F tended to increase the rate of decay of both varieties compared to 41°F and this became more pronounced with increasing time in storage and higher CO<sub>2</sub> levels.

Erwinia Decay - Following Reconditioning (Table 3)

Carbon Dioxide Effects

48 + 95 + 134 days - The analysis of variance showed a non-significant F test at the 5% level.

175 days - Increasing the level of CO<sub>2</sub> to 8% at 41°F during storage significantly accelerated the rate of decay of both varieties following reconditioning. A similar effect of CO<sub>2</sub> followed 32°F storage for Russet Burbank but the difference between air and 8% CO<sub>2</sub> was not significant.

Summary of CO<sub>2</sub> Effects - Reconditioning did not entirely eliminate the detrimental effects of high CO<sub>2</sub> during storage in accelerating the rate of tuber decay by Erwinia. However, the effects were only significant after 175 days of storage.

### Variety Comparison

Following reconditioning the two varieties previously stored under comparable conditions showed similar rates of Erwinia decay.

### Storage Temperature Effects

48 days - The rate of decay of Russet Burbank previously stored at 32°F was the same as when stored at 41°F. Prior storage of WC230-14 in 4 and 8% CO<sub>2</sub> at 41°F resulted in a significantly higher rate of decay than following storage at 32°F in the same atmospheres.

95 days - Russet Burbank stored in 4 and 8% CO<sub>2</sub> at 32 and 41°F decayed at similar rates. However when stored in air, tubers from 32°F decayed significantly faster. WC230-14 stored at 41°F in all atmospheres decayed at a significantly higher rate than when stored at 32°F.

134 + 175 days - The analysis of variance F test was non-significant at the 5% level.

Summary of Storage Temperature Effects - Although some significant differences in the rate of decay between storage temperatures occurred following reconditioning, the differences were small. For the most part the effect of storage temperature on rate of decay by Erwinia was removed by reconditioning.

Fusarium Decay - Direct from Storage (Table 4)Carbon Dioxide Effects

48 days - The rate of WC230-14 decay following storage at 32° or 41°F was not influenced by the level of CO<sub>2</sub>. Russet Burbank tubers stored in 8% CO<sub>2</sub> at 41°F decayed significantly faster than tubers stored in air or 4% CO<sub>2</sub>. The rate of Russet Burbank decay following 32°F storage was variable and was not affected by the level of CO<sub>2</sub>.

95 days - WC230-14 decayed more rapidly following storage in 8% CO<sub>2</sub> than in air or 4% CO<sub>2</sub> at both 32 and 41°F. Russet Burbank tubers stored at 32°F in 8% CO<sub>2</sub> decayed more rapidly than tubers stored in air or 4% CO<sub>2</sub>. No differences in the rate of decay due to CO<sub>2</sub> occurred when Russet Burbank was stored in 41°F.

134 days - A significant increase in the rate of decay was shown by Russet Burbank following storage in 8% CO<sub>2</sub> at 41°F when compared to tubers stored in air. Following storage in 8% CO<sub>2</sub> at 32°F, Russet Burbank decayed at a significantly higher rate than when stored in air or 4% CO<sub>2</sub>. The level of CO<sub>2</sub> during 41°F storage did not change the rate of decay of WC230-14 tubers. However, storage in either 4 or 8% CO<sub>2</sub> significantly increased the rate of decay compared to storage in air.

175 days - The rate of decay of Russet Burbank and WC230-14 tubers stored at 41°F was not affected by the level of CO<sub>2</sub> during storage. However when stored at 32°F in 8% CO<sub>2</sub>, both varieties

Table 4. The influence of storage time, temperature, atmosphere, and reconditioning on the decay of potato tissue by Fusarium. Values shown are volume of tissue destroyed (cc. per inoculation).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	1.1 <sup>de<sup>2/</sup></sup>	1.7 <sup>bc</sup>	0	1.0 <sup>cde</sup>	1.4 <sup>ab</sup>	0	1.8 <sup>cd</sup>	2.2 <sup>a</sup>	0	2.5 <sup>b</sup>	2.2 <sup>b</sup>	12	1.6	1.9	3
		4%	1.3 <sup>de</sup>	2.1 <sup>a</sup>	0	1.2 <sup>bc</sup>	1.5 <sup>a</sup>	0	2.0 <sup>bc</sup>	1.9 <sup>b</sup>	5	2.7 <sup>b</sup>	2.2 <sup>b</sup>	19	1.8	1.9	6
		8%	2.1 <sup>b</sup>	2.1 <sup>a</sup>	0	1.1 <sup>cd</sup>	1.5 <sup>a</sup>	0	2.2 <sup>b</sup>	2.0 <sup>b</sup>	9	2.5 <sup>b</sup>	2.6 <sup>a</sup>	0	2.0	2.1	2
41°	WC230-14	Air	1.1 <sup>de</sup>	1.1 <sup>d</sup>	0	0.9 <sup>de</sup>	1.0 <sup>de</sup>	0	1.2 <sup>f</sup>	1.2 <sup>de</sup>	0	1.4 <sup>d</sup>	1.4 <sup>de</sup>	0	1.2	1.2	0
		4%	1.3 <sup>de</sup>	1.1 <sup>d</sup>	15	0.9 <sup>de</sup>	1.2 <sup>bcd</sup>	0	1.3 <sup>ef</sup>	1.1 <sup>ef</sup>	15	1.4 <sup>d</sup>	1.2 <sup>ef</sup>	14	1.2	1.2	11
		8%	1.2 <sup>de</sup>	1.1 <sup>d</sup>	8	1.1 <sup>cd</sup>	1.2 <sup>bcd</sup>	0	1.4 <sup>ef</sup>	1.1 <sup>ef</sup>	21	1.6 <sup>cd</sup>	1.2 <sup>ef</sup>	25	1.3	1.2	14
32°	R. Burbank	Air	2.4 <sup>a</sup>	1.7 <sup>bc</sup>	29	1.2 <sup>bc</sup>	1.2 <sup>bcd</sup>	0	1.6 <sup>de</sup>	1.5 <sup>c</sup>	6	2.0 <sup>c</sup>	2.0 <sup>c</sup>	0	1.8	1.6	9
		4%	1.8 <sup>c</sup>	1.9 <sup>b</sup>	0	1.1 <sup>cd</sup>	1.1 <sup>cde</sup>	0	1.6 <sup>de</sup>	1.1 <sup>ef</sup>	31	1.9 <sup>c</sup>	1.4 <sup>de</sup>	26	1.6	1.4	14
		8%	2.0 <sup>b</sup>	1.6 <sup>c</sup>	20	1.4 <sup>ab</sup>	0.9 <sup>e</sup>	38	2.8 <sup>a</sup>	1.4 <sup>cd</sup>	50	4.5 <sup>a</sup>	1.3 <sup>def</sup>	71	2.7	1.3	45
32°	WC230-14	Air	1.2 <sup>de</sup>	1.1 <sup>d</sup>	8	1.0 <sup>cde</sup>	1.1 <sup>cde</sup>	0	1.3 <sup>ef</sup>	1.1 <sup>ef</sup>	15	1.6 <sup>cd</sup>	1.4 <sup>de</sup>	13	1.3	1.2	9
		4%	1.4 <sup>d</sup>	1.1 <sup>d</sup>	21	1.2 <sup>bc</sup>	1.2 <sup>bcd</sup>	0	1.7 <sup>d</sup>	1.1 <sup>ef</sup>	35	1.9 <sup>c</sup>	1.4 <sup>de</sup>	26	1.6	1.2	21
		8%	1.3 <sup>de</sup>	1.2 <sup>d</sup>	8	1.4 <sup>ab</sup>	1.2 <sup>bcd</sup>	14	1.7 <sup>d</sup>	1.1 <sup>ef</sup>	35	2.8 <sup>b</sup>	1.4 <sup>de</sup>	50	1.8	1.2	27

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62° F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

decayed significantly more rapidly than when stored in air or 4% CO<sub>2</sub>.

Summary of CO<sub>2</sub> Effects - Increasing the level of CO<sub>2</sub> to 8% in the storage frequently increased the rate of Fusarium decay of both varieties. The effect was greater at 32° F than at 41° F and was also more pronounced later in the storage period.

#### Variety Comparison

48 days - Russet Burbank decayed significantly faster than WC230-14 following storage in 8% CO<sub>2</sub> at 41° F. Irrespective of the atmosphere, Russet Burbank decayed at a significantly higher rate than WC230-14 following storage at 32° F.

95 days - Russet Burbank decayed significantly faster than WC230-14 following 41° F storage in 4% CO<sub>2</sub>.

134 + 175 days - Russet Burbank decayed at a significantly higher rate than WC230-14 following storage at 41° F in air, 4 or 8% CO<sub>2</sub>. Following 32° F storage in 8% CO<sub>2</sub>, Russet Burbank decayed significantly faster than WC230-14.

Summary of Variety Effects - In most comparisons, WC230-14 was more resistant to Fusarium decay than Russet Burbank.

#### Storage Temperature Effects

48 days - Russet Burbank showed significantly more decay when previously stored in air and 4% CO<sub>2</sub> at 32° F than when stored in air and 4% CO<sub>2</sub> at 41° F. The decay of WC230-14 was similar at 32 and 41° F.

95 days - Significantly more rapid decay of Russet Burbank followed storage at 32°F in 8% CO<sub>2</sub> than 41°F storage in 8% CO<sub>2</sub>. WC230-14 showed significantly more decay following storage at 32°F in 4 or 8% CO<sub>2</sub> than at 41°F in the same atmospheres.

134 days - Russet Burbank decayed significantly more rapidly following 41°F storage in 4% CO<sub>2</sub> than following 32°F in 4% CO<sub>2</sub>. However when CO<sub>2</sub> was increased to 8%, Russet Burbank decayed more rapidly following 32°F storage. WC230-14 decayed more rapidly following storage at 32°F in 4 and 8% CO<sub>2</sub> than following storage at 41°F.

175 days - Russet Burbank showed significantly more decay following 41°F storage in air and 4% CO<sub>2</sub> than following 32°F storage in air and 4% CO<sub>2</sub>. However, as occurred at 134 days, increasing CO<sub>2</sub> to 8% resulted in Russet Burbank decaying more rapidly following 32°F storage. WC230-14 decayed more rapidly after storage at 32°F in 4 and 8% CO<sub>2</sub> than after 41°F in the same atmospheres.

Summary of Storage Temperature Effects- In most comparisons, WC230-14 decayed more rapidly following storage at 32°F than when stored at 41°F. However, decay of Russet Burbank was more rapid following storage at 32°F only in 8% CO<sub>2</sub>. The temperature effects were more variable when Russet Burbank was stored in air and 4% CO<sub>2</sub>.

## Fusarium Decay - Following Reconditioning (Table 4)

### Carbon Dioxide Effects

With respect to tuber decay by Fusarium, reconditioning removed any detrimental effects attributed to CO<sub>2</sub> levels during storage. This was particularly noticeable for both varieties following 175 days of storage at 32° F.

### Variety Comparison

In all comparisons following 41° F storage and reconditioning, Russet Burbank decayed more rapidly than WC230-14. When both varieties were stored at 32° F, the results were variable but in most comparisons Russet Burbank showed more rapid decay.

### Storage Temperature Effects

Russet Burbank, previously stored at 41° F under all atmospheres and then reconditioned, decayed more rapidly than when stored at 32° F. WC230-14, in almost all comparisons did not show any differences in the rate of decay between 32 and 41° F.

### Reducing Sugar Content - Direct from Storage (Table 5)

The two reducing sugars, fructose and glucose, responded similarly to CO<sub>2</sub> level, storage temperature and variety. The results of fructose analysis are shown in Table A1 (Appendix) and for glucose in Table A2. Due to their similar behavior, the two sugars were combined and are discussed as reducing sugars.

Table 5. The influence of storage time, temperature, atmosphere, and reconditioning on the reducing sugar content of potato tissue. Values shown are percent reducing sugars (Fresh Weight Basis).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	.45 <sup>d<sup>2/</sup></sup>	.37 <sup>e</sup>	18	.46 <sup>e</sup>	.30 <sup>d</sup>	35	.51 <sup>g</sup>	.09 <sup>f</sup>	82	.47 <sup>e</sup>	.15 <sup>d</sup>	68	.47	.23	51
		4%	.59 <sup>cd</sup>	.38 <sup>e</sup>	36	.84 <sup>de</sup>	.45 <sup>d</sup>	46	.71 <sup>fg</sup>	.21 <sup>f</sup>	70	.79 <sup>d</sup>	.16 <sup>d</sup>	80	.73	.30	58
		8%	.92 <sup>bcd</sup>	.61 <sup>de</sup>	34	1.11 <sup>cd</sup>	.45 <sup>d</sup>	59	.93 <sup>ef</sup>	.36 <sup>ef</sup>	61	.81 <sup>d</sup>	.21 <sup>d</sup>	74	.94	.41	57
41°	WC230-14	Air	.57 <sup>d</sup>	.74 <sup>de</sup>	0	.89 <sup>de</sup>	.81 <sup>bc</sup>	9	.82 <sup>f</sup>	.65 <sup>cdef</sup>	21	.92 <sup>cd</sup>	.88 <sup>bc</sup>	4	.80	.77	9
		4%	.93 <sup>bcd</sup>	.92 <sup>cd</sup>	1	1.12 <sup>cd</sup>	1.01 <sup>b</sup>	10	1.14 <sup>de</sup>	.82 <sup>bcd</sup>	28	1.07 <sup>c</sup>	.77 <sup>c</sup>	28	1.07	.88	17
		8%	1.36 <sup>ab</sup>	1.11 <sup>bc</sup>	18	1.80 <sup>ab</sup>	.93 <sup>b</sup>	48	1.30 <sup>cd</sup>	1.00 <sup>bcd</sup>	23	.89 <sup>cd</sup>	.89 <sup>bc</sup>	0	1.34	.98	22
32°	R. Burbank	Air	1.25 <sup>bc</sup>	.55 <sup>de</sup>	56	1.97 <sup>a</sup>	.55 <sup>cd</sup>	72	1.84 <sup>b</sup>	.49 <sup>def</sup>	73	1.41 <sup>b</sup>	.43 <sup>cd</sup>	70	1.62	.51	68
		4%	.97 <sup>bcd</sup>	.60 <sup>de</sup>	38	1.64 <sup>abc</sup>	.80 <sup>bc</sup>	51	1.48 <sup>c</sup>	.96 <sup>bcd</sup>	35	1.65 <sup>ab</sup>	.87 <sup>bc</sup>	47	1.44	.81	43
		8%	.86 <sup>bcd</sup>	.69 <sup>de</sup>	20	1.35 <sup>bcd</sup>	.97 <sup>b</sup>	28	1.29 <sup>cd</sup>	.99 <sup>bcd</sup>	23	1.51 <sup>b</sup>	1.31 <sup>ab</sup>	13	1.25	.99	21
32°	WC230-14	Air	1.76 <sup>a</sup>	1.30 <sup>ab</sup>	26	1.82 <sup>ab</sup>	1.43 <sup>a</sup>	21	1.91 <sup>ab</sup>	1.33 <sup>ab</sup>	30	1.62 <sup>ab</sup>	1.75 <sup>a</sup>	0	1.78	1.45	19
		4%	1.83 <sup>a</sup>	1.46 <sup>ab</sup>	20	1.82 <sup>ab</sup>	1.62 <sup>a</sup>	11	2.10 <sup>a</sup>	1.44 <sup>a</sup>	31	1.59 <sup>b</sup>	1.52 <sup>a</sup>	4	1.84	1.51	17
		8%	1.77 <sup>a</sup>	1.60 <sup>a</sup>	10	1.94 <sup>a</sup>	1.33 <sup>a</sup>	31	1.97 <sup>ab</sup>	1.23 <sup>abc</sup>	38	1.87 <sup>a</sup>	1.79 <sup>a</sup>	4	1.89	1.49	21

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62° F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

### Carbon Dioxide Effects

48 + 95 + 134 days - Both varieties stored at 41<sup>o</sup>F increased steadily in reducing sugar content with an increase in CO<sub>2</sub>. Russet Burbank stored at 32<sup>o</sup>F steadily decreased in reducing sugar content with an increase in CO<sub>2</sub>. Reducing sugar content in WC230-14 stored at 32<sup>o</sup>F did not change consistently in response to CO<sub>2</sub>.

175 days - The results were quite variable. Only Russet Burbank stored at 41<sup>o</sup>F consistently increased in reducing sugar content with an increase in CO<sub>2</sub>.

Summary of CO<sub>2</sub> Effects - Both varieties increased in reducing sugar content with increasing CO<sub>2</sub> at 41<sup>o</sup>F. Russet Burbank stored at 32<sup>o</sup>F decreased in reducing sugar content with an increase in CO<sub>2</sub>. Response of WC230-14 stored at 32<sup>o</sup>F was variable.

### Variety Comparison

48 days - In all comparisons at both 32 and 41<sup>o</sup>F, WC230-14 was higher in reducing sugar content than Russet Burbank. The differences were significant at 32<sup>o</sup>F but not at 41<sup>o</sup>F.

95 days - WC230-14 was higher in reducing sugar content than Russet Burbank in all comparisons at 41<sup>o</sup>F. At 32<sup>o</sup>F, WC230-14 was higher in reducing sugar content than Russet Burbank when both were stored in 4 and 8% CO<sub>2</sub> but slightly lower when stored in air. Significant differences occurred under 8% CO<sub>2</sub> at both 41 and 32<sup>o</sup>F.

134 days - In all comparisons WC230-14 was higher in reducing sugar content than Russet Burbank. All differences were significant except in air at 32° F.

175 days - WC230-14 was higher in reducing sugar content than Russet Burbank in all comparisons except at 32° F under 4% CO<sub>2</sub>.

Summary of Variety Comparison - In almost all comparisons, WC230-14 contained more reducing sugars than Russet Burbank.

#### Storage Temperature Effects

In nearly all comparisons, both varieties synthesized far more reducing sugars when stored at 32° F than when stored at 41° F.

#### Reducing Sugar Content - Following Reconditioning (Table 5)

#### Carbon Dioxide Effects

In nearly all comparisons, Russet Burbank and WC230-14 stored in 4 or 8% CO<sub>2</sub> at either 32 or 41° F retained more reducing sugars following reconditioning than when previously stored in air.

#### Variety Comparison

WC230-14, in all comparisons following previous storage at either 32 or 41° F, decreased slightly (9 to 22% on the average) in reducing sugar content during reconditioning. Russet Burbank exhibited a much greater capacity (21 to 68% on the average) to eliminate reducing sugars accumulated during storage at either 32 or 41° F.

### Storage Temperature Effects

Compared to 41<sup>o</sup>F, both varieties previously stored at 32<sup>o</sup>F contained more reducing sugars following reconditioning.

### Sucrose Content - Direct from Storage (Table 6)

#### Carbon Dioxide Effects

48 days - WC230-14 increased in sucrose content with increasing CO<sub>2</sub> during both 32 and 41<sup>o</sup>F storage. The differences were not significant at 41<sup>o</sup>F. However, sucrose was significantly higher following storage in 8% CO<sub>2</sub> at 32<sup>o</sup>F than when stored in air or 4% CO<sub>2</sub>. Russet Burbank also increased in sucrose under a CO<sub>2</sub> atmosphere at both 32 and 41<sup>o</sup>F. The differences were non-significant at 41<sup>o</sup>F but exposure to 4 and 8% CO<sub>2</sub> at 32<sup>o</sup>F resulted in equal and significantly higher sucrose levels than in air.

95 days - The concentration of sucrose found in Russet Burbank following storage at 32<sup>o</sup>F in 4 and 8% CO<sub>2</sub> was again significantly higher than in tubers stored in air. WC230-14 also showed similar but non-significant increases in sucrose due to CO<sub>2</sub> at 32<sup>o</sup>F. A non-significant increase in sucrose was also shown by both varieties from increasing CO<sub>2</sub> at 41<sup>o</sup>F.

134 + 175 days - In all comparisons, the sucrose content of both varieties was progressively increased by increasing CO<sub>2</sub> at both 32 and 41<sup>o</sup>F.

Table 6. The influence of storage time, temperature, atmosphere, and reconditioning on the sucrose content of potato tissue. Values shown are percent sucrose (Fresh Weight Basis).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	.16 <sup>e2/</sup>	.08 <sup>cd</sup>	50	.06 <sup>f</sup>	.02 <sup>c</sup>	67	.08 <sup>i</sup>	.07 <sup>c</sup>	13	.06 <sup>ijk</sup>	.06 <sup>c</sup>	0	.09	.06	33
		4%	.48 <sup>e</sup>	.14 <sup>bcd</sup>	71	.20 <sup>f</sup>	.01 <sup>c</sup>	95	.16 <sup>i</sup>	.11 <sup>c</sup>	31	.14 <sup>ijk</sup>	.09 <sup>c</sup>	36	.25	.09	58
		8%	.34 <sup>e</sup>	.10 <sup>bcd</sup>	71	.23 <sup>f</sup>	.09 <sup>c</sup>	61	.29 <sup>hi</sup>	.04 <sup>c</sup>	86	.34 <sup>hi</sup>	.08 <sup>c</sup>	76	.30	.08	74
41°	WC230-14	Air	.29 <sup>e</sup>	.00 <sup>d</sup>	100	.08 <sup>f</sup>	.03 <sup>c</sup>	63	.17 <sup>i</sup>	.17 <sup>bc</sup>	0	.30 <sup>hij</sup>	.18 <sup>c</sup>	40	.21	.10	51
		4%	.37 <sup>e</sup>	.13 <sup>bcd</sup>	65	.50 <sup>ef</sup>	.12 <sup>c</sup>	76	.63 <sup>efgh</sup>	.15 <sup>bc</sup>	76	.66 <sup>h</sup>	.13 <sup>c</sup>	80	.54	.13	74
		8%	.57 <sup>de</sup>	.21 <sup>bc</sup>	63	.53 <sup>ef</sup>	.55 <sup>ab</sup>	0	.90 <sup>cdef</sup>	.47 <sup>ab</sup>	48	1.63 <sup>bcde</sup>	.61 <sup>a</sup>	63	.91	.46	44
32°	R. Burbank	Air	.96 <sup>cd</sup>	.12 <sup>bcd</sup>	88	.54 <sup>ef</sup>	.12 <sup>c</sup>	78	1.18 <sup>cd</sup>	.14 <sup>bc</sup>	88	1.34 <sup>cdef</sup>	.16 <sup>c</sup>	88	1.01	.14	86
		4%	1.81 <sup>a</sup>	.48 <sup>a</sup>	73	1.33 <sup>abc</sup>	.20 <sup>bc</sup>	85	1.59 <sup>ab</sup>	.29 <sup>abc</sup>	82	1.66 <sup>bcd</sup>	.33 <sup>bc</sup>	80	1.60	.33	80
		8%	1.74 <sup>ab</sup>	.55 <sup>a</sup>	68	1.72 <sup>a</sup>	.60 <sup>a</sup>	65	1.70 <sup>a</sup>	.54 <sup>a</sup>	68	1.86 <sup>ab</sup>	.50 <sup>ab</sup>	73	1.76	.55	69
32°	WC230-14	Air	.42 <sup>e</sup>	.13 <sup>bcd</sup>	69	.90 <sup>bcde</sup>	.08 <sup>c</sup>	91	.83 <sup>defg</sup>	.24 <sup>abc</sup>	71	1.20 <sup>gf</sup>	.02 <sup>c</sup>	98	.84	.12	82
		4%	.59 <sup>de</sup>	.25 <sup>b</sup>	58	1.47 <sup>ab</sup>	.20 <sup>bc</sup>	86	.95 <sup>cde</sup>	.28 <sup>abc</sup>	71	1.71 <sup>bc</sup>	.30 <sup>bc</sup>	82	1.18	.26	74
		8%	1.33 <sup>c</sup>	.14 <sup>bcd</sup>	89	1.26 <sup>abcd</sup>	.29 <sup>abc</sup>	77	1.25 <sup>bc</sup>	.56 <sup>a</sup>	55	2.19 <sup>a</sup>	.51 <sup>ab</sup>	77	1.51	.36	75

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62° F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

Summary of CO<sub>2</sub> Effects - Increasing CO<sub>2</sub> at 32 and 41<sup>o</sup>F increased the sucrose content of both varieties above than found in tubers stored in air. The increase was usually more pronounced at 32<sup>o</sup>F.

Variety Comparison

48 days - At 41<sup>o</sup>F, WC230-14 and Russet Burbank contained similar concentrations of sucrose. At 32<sup>o</sup>F, Russet Burbank contained significantly more sucrose than WC230-14.

95 days - The sucrose concentration was similar in both varieties when compared under the same conditions.

134 days - At 41<sup>o</sup>F, WC230-14 contained more sucrose than Russet Burbank while at 32<sup>o</sup>F the reverse occurred.

175 days - WC230-14 contained more sucrose than Russet Burbank following 41<sup>o</sup>F storage. The differences were significant following storage in 4 and 8% CO<sub>2</sub>. At 32<sup>o</sup>F, Russet Burbank contained more sucrose than WC230-14 when both were stored in air but less sucrose when both were stored in 4 or 8% CO<sub>2</sub>. The differences were not significant.

Summary of Variety Comparison - Generally WC230-14 had a higher sucrose content than Russet Burbank when stored at 41<sup>o</sup>F and lower when stored at 32<sup>o</sup>F.

### Storage Temperature Effects

In all comparisons for each observation, more sucrose accumulated in both varieties when they were stored at 32° F as compared to 41° F. Russet Burbank generally showed a greater difference in sucrose content between 32 and 41° F than did WC230-14.

### Sucrose Content - Following Reconditioning (Table 6)

#### Carbon Dioxide Effects

48 days - WC230-14 stored at 41° F and Russet Burbank stored at 32° F retained significantly more sucrose after reconditioning when previously stored in 4 or 8% CO<sub>2</sub> than when stored in air. The other differences were variable and non-significant.

95 days - Russet Burbank previously stored at 32° F in 8% CO<sub>2</sub> retained more sucrose than when stored at the same temperature in air or 4% CO<sub>2</sub>. This same effect was shown by WC230-14 stored at 41° F in 8% CO<sub>2</sub>.

134 + 175 days - Russet Burbank stored at 41° F did not differ in sucrose content at the various CO<sub>2</sub> levels during storage. However, Russet Burbank stored at 32° F and WC230-14 stored at 32 and 41° F retained more sucrose after reconditioning when previously stored in 8% CO<sub>2</sub> than when stored in air or 4% CO<sub>2</sub>.

Summary of CO<sub>2</sub> Effects - In most comparisons, tubers of both varieties retained more sucrose after reconditioning when stored in

8% CO<sub>2</sub> than when previously stored in air or 4% CO<sub>2</sub>. This was consistent following storage at 32° F but more variable following 41° F storage.

#### Variety Comparison

48 days - No differences in sucrose level existed between varieties previously stored at 41° F. However, when previously stored at 32° F in 4 and 8% CO<sub>2</sub>, Russet Burbank retained significantly more sucrose than WC230-14.

95 + 134 + 175 days - WC230-14 contained more sucrose than Russet Burbank when both had been previously stored at 41° F in 8% CO<sub>2</sub>. No other consistent differences between varieties were noted.

Summary of Variety Comparison - Reconditioning reduced the level of sucrose in both varieties following storage at 32 or 41° F. No marked differences were apparent between the varieties in their ability to eliminate sucrose during reconditioning.

#### Storage Temperature Effects

Following reconditioning, in most comparisons, both varieties still contained more sucrose when previously stored at 32° than when stored at 41° F. The only reversal occurred in WC 230-14 previously stored in 8% CO<sub>2</sub>.

134 + 175 days - In most comparisons, both varieties retained more sucrose following reconditioning when previously stored at

32<sup>o</sup>F than when stored at 41<sup>o</sup>F. The differences were not large and usually non-significant.

Summary of Storage Temperature Effects - In most comparisons both varieties contained more sucrose following reconditioning when previously stored at 32<sup>o</sup>F than when stored at 41<sup>o</sup>F. This was not due to a slower rate of reconditioning but to the higher accumulation of sucrose following 32<sup>o</sup>F storage.

Total Sugar Content - Direct from Storage (Table 7)

Carbon Dioxide Effects

48 days - Following storage in 4 and 8% CO<sub>2</sub> at 32 or 41<sup>o</sup>F, Russet Burbank contained significantly more total sugar than when stored in air. Total sugar content increased significantly when WC230-14 was stored at 41<sup>o</sup>F with an increase in the CO<sub>2</sub> level of the storage atmosphere. At 32<sup>o</sup>F, WC230-14 stored in 8% CO<sub>2</sub> contained significantly more total sugar than when stored in air or 4% CO<sub>2</sub>.

95 days - Increased CO<sub>2</sub> level during storage at 32 or 41<sup>o</sup>F increased the total sugar content of both varieties. Usually the highest sugar concentration resulted from storage in 8% CO<sub>2</sub> although exposure to 4% CO<sub>2</sub> also resulted in a significant increase in total sugar when compared to storage in air.

134 days - With the exception of Russet Burbank stored at 32<sup>o</sup>F, increasing the CO<sub>2</sub> level during storage significantly increased the

Table 7. The influence of storage time, temperature, atmosphere, and reconditioning on the total sugar content of potato tissue. Values shown are percent total sugars (Fresh Weight Basis).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	.62 <sup>h<sup>2/</sup></sup>	.45 <sup>d</sup>	27	.52 <sup>i</sup>	.30 <sup>g</sup>	48	.60 <sup>f</sup>	.17 <sup>h</sup>	72	.53 <sup>f</sup>	.21 <sup>f</sup>	60	.57	.28	52
		4%	1.09 <sup>fg</sup>	.52 <sup>d</sup>	52	1.05 <sup>h</sup>	.46 <sup>fg</sup>	56	.89 <sup>ef</sup>	.33 <sup>gh</sup>	63	.94 <sup>e</sup>	.25 <sup>f</sup>	73	.99	.39	61
		8%	1.28 <sup>f</sup>	.71 <sup>d</sup>	45	1.34 <sup>g</sup>	.55 <sup>fg</sup>	59	1.24 <sup>e</sup>	.40 <sup>g</sup>	68	1.16 <sup>e</sup>	.30 <sup>f</sup>	74	1.26	.49	62
41°	WC230-14	Air	.87 <sup>gh</sup>	.72 <sup>d</sup>	17	.98 <sup>h</sup>	.83 <sup>de</sup>	15	.99 <sup>e</sup>	.83 <sup>ef</sup>	16	1.23 <sup>e</sup>	1.06 <sup>d</sup>	14	1.02	.86	16
		4%	1.33 <sup>f</sup>	1.05 <sup>c</sup>	21	1.63 <sup>f</sup>	1.14 <sup>c</sup>	30	1.80 <sup>d</sup>	.98 <sup>e</sup>	46	1.76 <sup>d</sup>	.89 <sup>de</sup>	49	1.63	1.02	37
		8%	1.95 <sup>e</sup>	1.32 <sup>bc</sup>	32	2.32 <sup>e</sup>	1.51 <sup>b</sup>	35	2.25 <sup>c</sup>	1.49 <sup>c</sup>	34	2.60 <sup>c</sup>	1.54 <sup>bc</sup>	41	2.28	1.47	36
32°	R. Burbank	Air	2.26 <sup>de</sup>	.72 <sup>d</sup>	68	2.54 <sup>de</sup>	.67 <sup>ef</sup>	74	3.08 <sup>ab</sup>	.64 <sup>f</sup>	79	2.82 <sup>c</sup>	.60 <sup>ef</sup>	79	2.68	.66	75
		4%	2.87 <sup>ab</sup>	1.11 <sup>c</sup>	61	3.03 <sup>bc</sup>	1.01 <sup>cd</sup>	67	3.15 <sup>ab</sup>	1.27 <sup>d</sup>	60	3.40 <sup>b</sup>	1.21 <sup>cd</sup>	64	3.11	1.15	63
		8%	2.69 <sup>bc</sup>	1.27 <sup>bc</sup>	53	3.16 <sup>ab</sup>	1.59 <sup>ab</sup>	50	3.09 <sup>ab</sup>	1.56 <sup>bc</sup>	50	3.46 <sup>b</sup>	1.84 <sup>b</sup>	47	3.10	1.57	50
32°	WC230-14	Air	2.20 <sup>de</sup>	1.43 <sup>b</sup>	35	2.77 <sup>cd</sup>	1.51 <sup>b</sup>	45	2.78 <sup>b</sup>	1.58 <sup>bc</sup>	43	2.88 <sup>c</sup>	1.76 <sup>b</sup>	39	2.66	1.57	41
		4%	2.45 <sup>cd</sup>	1.72 <sup>a</sup>	30	3.37 <sup>a</sup>	1.83 <sup>a</sup>	46	3.11 <sup>ab</sup>	1.73 <sup>ab</sup>	44	3.38 <sup>b</sup>	1.83 <sup>b</sup>	46	3.08	1.78	42
		8%	3.17 <sup>a</sup>	1.74 <sup>a</sup>	45	3.26 <sup>ab</sup>	1.64 <sup>ab</sup>	50	3.28 <sup>a</sup>	1.82 <sup>a</sup>	46	4.17 <sup>a</sup>	2.33 <sup>a</sup>	44	3.47	1.88	46

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62° F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

total sugar content of both varieties. When Russet Burbank was stored at 32°F, total sugar content was similar whether stored in air, 4 or 8% CO<sub>2</sub>.

175 days - In all comparisons an increase in the CO<sub>2</sub> level during storage increased the total sugar content.

Summary of CO<sub>2</sub> Effects - In nearly all comparisons, increased levels of CO<sub>2</sub> during storage at 32 and 41°F increased the total sugar content of both varieties.

#### Variety Comparison

48 days - WC230-14 contained more total sugar than Russet Burbank when both were stored at 41°F. In most comparisons the difference in content of total sugars was statistically significant. Following 32°F storage in 4% CO<sub>2</sub>, Russet Burbank was significantly higher in total sugar content than WC230-14. The reverse was true in 8% CO<sub>2</sub>.

95 days - In all comparisons WC230-14 tubers had a higher total sugar content than Russet Burbank. All differences following 41°F were significant and also following 32°F storage in 4% CO<sub>2</sub>.

134 days - Following 41°F storage, WC230-14 tubers contained significantly more total sugar than Russet Burbank. Following 32°F, the differences in total sugar content between varieties were variable and non-significant.

175 days - Following 41<sup>o</sup>F storage, WC230-14 contained significantly more total sugar than Russet Burbank. Following 32<sup>o</sup>F storage in 8% CO<sub>2</sub>, WC230-14 was significantly higher in total sugar content than Russet Burbank. No difference was observed when the varieties were stored at 32<sup>o</sup>F in air or 4% CO<sub>2</sub>.

Summary of Variety Comparison - Following 41<sup>o</sup>F storage, WC230-14 contained more total sugar than Russet Burbank. The results were more variable following 32<sup>o</sup>F storage and significant differences were not often obtained.

#### Storage Temperature Effects

In all comparisons, both varieties contained significantly more total sugar following 32<sup>o</sup>F than following 41<sup>o</sup>F storage.

#### Total Sugar Content - Following Reconditioning (Table 7)

#### Carbon Dioxide Effects

48 days - Increasing the CO<sub>2</sub> level during storage resulted in a higher total sugar content in both varieties after a reconditioning period. In most comparisons, the total sugar content following storage in 4 or 8% CO<sub>2</sub> was significantly greater than following storage in air but no significant difference existed between 4 and 8% CO<sub>2</sub>.

95 + 134 + 175 days - Results were similar to 48 days with some variation in the statistical significance between certain treatments.

Summary of CO<sub>2</sub> Effects - In nearly all comparisons, an increase in the CO<sub>2</sub> level during storage resulted in the retention of more sugar following reconditioning.

#### Variety Comparison

In most comparisons, WC230-14 tubers contained significantly more total sugars following reconditioning than did Russet Burbank. This was attributed to the higher level of total sugars directly out of storage shown by WC230-14, particularly following 41<sup>o</sup>F, and the slower elimination of sugar during reconditioning. In all comparisons, Russet Burbank showed a higher % reduction in total sugar content during reconditioning than WC230-14.

#### Storage Temperature Effects

Storage of both varieties at 32<sup>o</sup>F in all atmospheres resulted in a greater retention of sugars following reconditioning than when stored at 41<sup>o</sup>F in comparable atmospheres.

## V. DISCUSSION

The following considers the important findings in regard to varietal similarities and differences, and attempts to develop meaningful relationships between constituent changes during storage and rate of Erwinia and Fusarium decay.

Measurements taken shortly after harvest and prior to storage showed that Russet Burbank and WC230-14 were similar in cell membrane permeability, reducing sugars, sucrose and total sugars (Table 1). Some initial differences were apparent between the varieties in regard to the rate of decay by Erwinia and Fusarium. Russet Burbank was decayed more rapidly by Fusarium than was WC230-14 and the reverse was true in regard to Erwinia.

During storage certain similarities and differences between the varieties became apparent. In most cases, the differences or similarities detected after 48 days in storage were maintained throughout the storage period. However, some differences became more accentuated with storage time at 32° F. Therefore, the observations made near the end of the storage period at 32° F were used in comparing the varieties.

After 175 days at 32° F, cell membrane permeability was 2 to 3 times higher in WC230-14 tubers than in Russet Burbank tubers (Fig. 5). Reconditioning markedly reduced the cell membrane

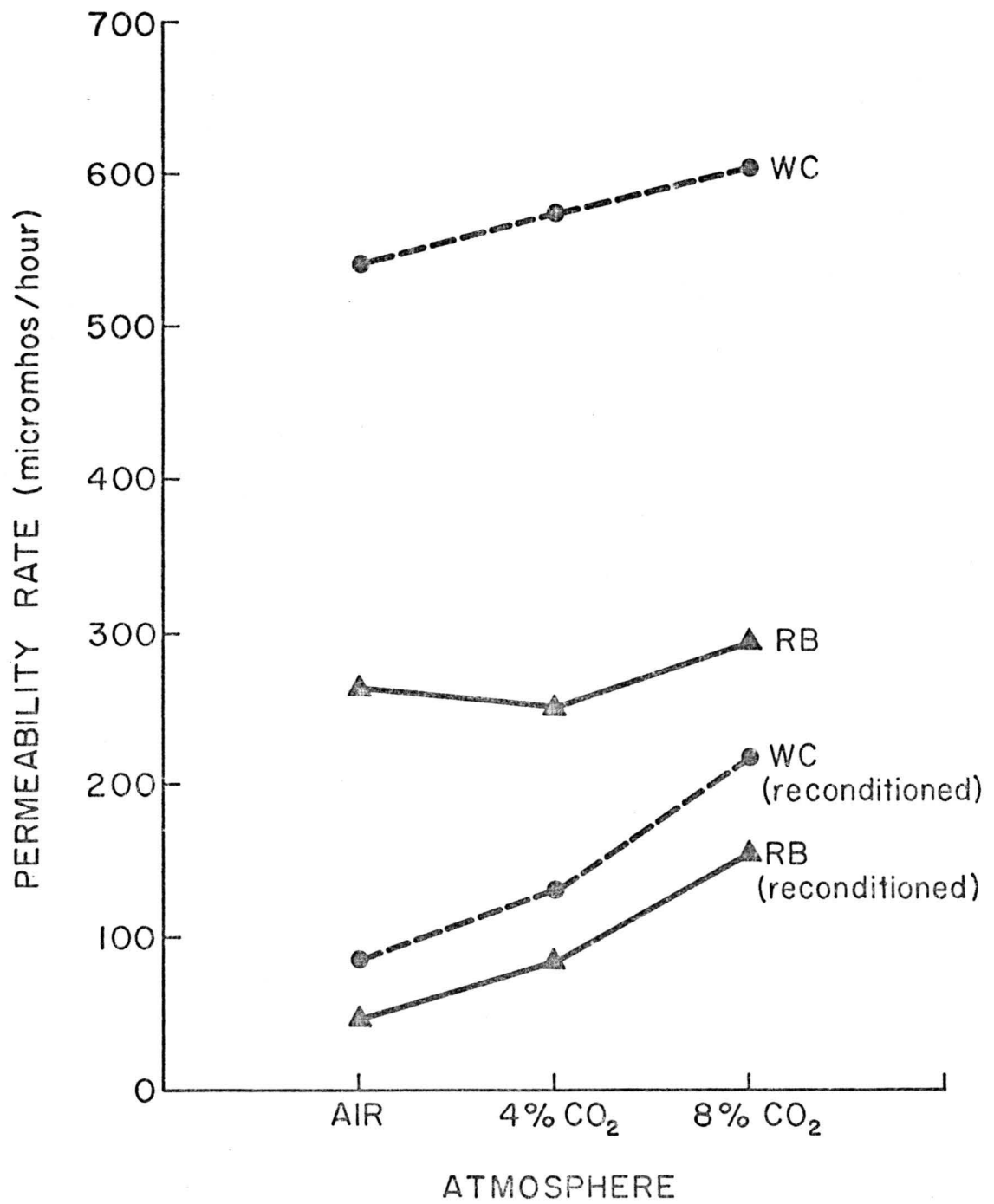


Figure 5. Effect of 32° F storage, CO<sub>2</sub>, and reconditioning on the cell membrane permeability of Russet Burbank and WC230-14 tubers after 175 days.

permeability of both varieties with WC230-14 showing a larger reduction than Russet Burbank. Therefore after reconditioning, the membrane permeability for WC230-14 was only slightly above that for Russet Burbank. Increasing CO<sub>2</sub> levels during storage usually resulted in increased membrane permeability in both varieties either directly from storage or following reconditioning.

Sucrose concentrations in Russet Burbank and WC230-14 were similar when stored under comparable conditions. Fig. 6 shows the variety comparison after 175 days storage at 32<sup>o</sup>F. Both varieties showed excellent and equal ability to reduce sucrose concentration during reconditioning. Storage in atmospheres with higher levels of CO<sub>2</sub> resulted in both varieties accumulating more sucrose during storage and more retention of sucrose during reconditioning.

In most comparisons, WC230-14 developed more reducing sugars during storage than did Russet Burbank (Table 5). However, the more striking difference between the two varieties was the nearly complete inability of WC230-14 to eliminate the reducing sugar accumulated during storage. Fig. 7 clearly shows this difference between varieties after 175 days storage at 32<sup>o</sup>F in air, 4 and 8% CO<sub>2</sub>. It should also be noted that increasing the CO<sub>2</sub> level during storage decreased the ability of Russet Burbank to eliminate reducing sugars during reconditioning.

No significant differences in the rate of Erwinia decay existed between the two varieties until after 175 days (Table 3). A slightly

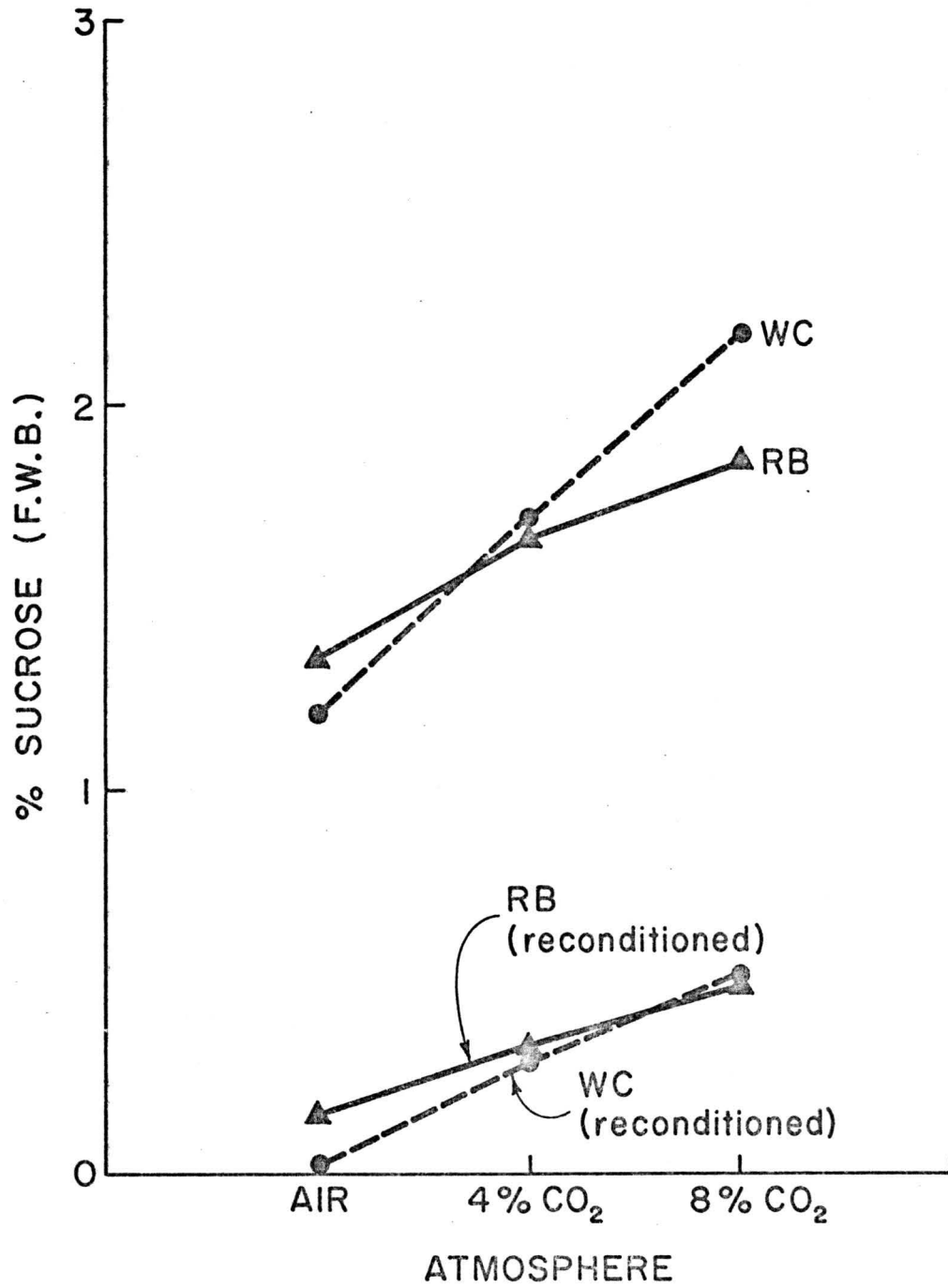


Figure 6. Effect of 32° F storage, CO<sub>2</sub>, and reconditioning on the sucrose content of Russet Burbank and WC230-14 tubers after 175 days.

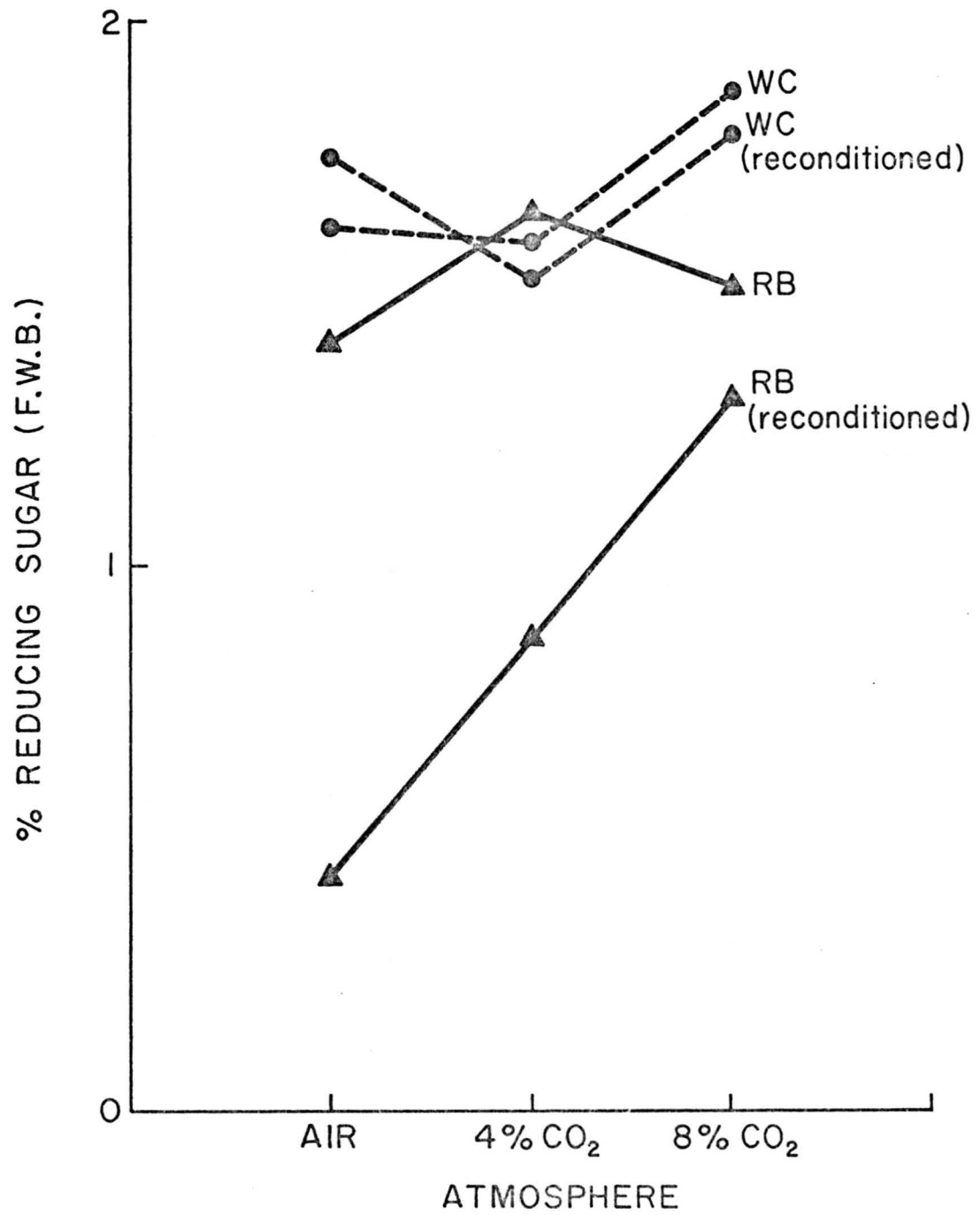


Figure 7. Effect of 32° F storage, CO<sub>2</sub>, and reconditioning on reducing sugar content of Russet Burbank and WC230-14 tubers after 175 days.

higher rate of Erwinia decay was shown by WC230-14 after 175 days of storage at 32° F in 4 and 8% CO<sub>2</sub> (Fig. 8). Following reconditioning, the rate of Erwinia decay of both varieties was markedly reduced and occurred at similar rates.

In most comparisons, Fusarium decayed Russet Burbank somewhat more rapidly than WC230-14 (Table 4). This was most noticeable after 175 days at 32° F in 8% CO<sub>2</sub> (Fig. 9). Reconditioning following storage at 32° F in 8% CO<sub>2</sub> greatly reduced the rate of Fusarium decay of both varieties.

The following statistical analyses were done to determine the variables most closely related to the rate of decay of tuber tissue by Erwinia or Fusarium. Evidence obtained from the analyses showed Erwinia tuber decay is related to the sucrose content of the tuber and cell membrane permeability. Fusarium decay is also related to the same two variables although the relationship was much less positive. As mentioned above, reconditioning of either variety following 175 days of storage at 32° F definitely reduced the rate of Erwinia and Fusarium decay (Fig. 8 and 9). The beneficial effect of reconditioning on reducing the rate of Erwinia decay was similar following storage at 32° F in air, 4 or 8% CO<sub>2</sub> (Fig. 8). In the case of Fusarium decay however, the beneficial effect of reconditioning was most noticeable following storage in 8% CO<sub>2</sub> (Fig. 9).

Irrespective of variety or storage atmosphere, the % sucrose and cell membrane permeability were consistently reduced by

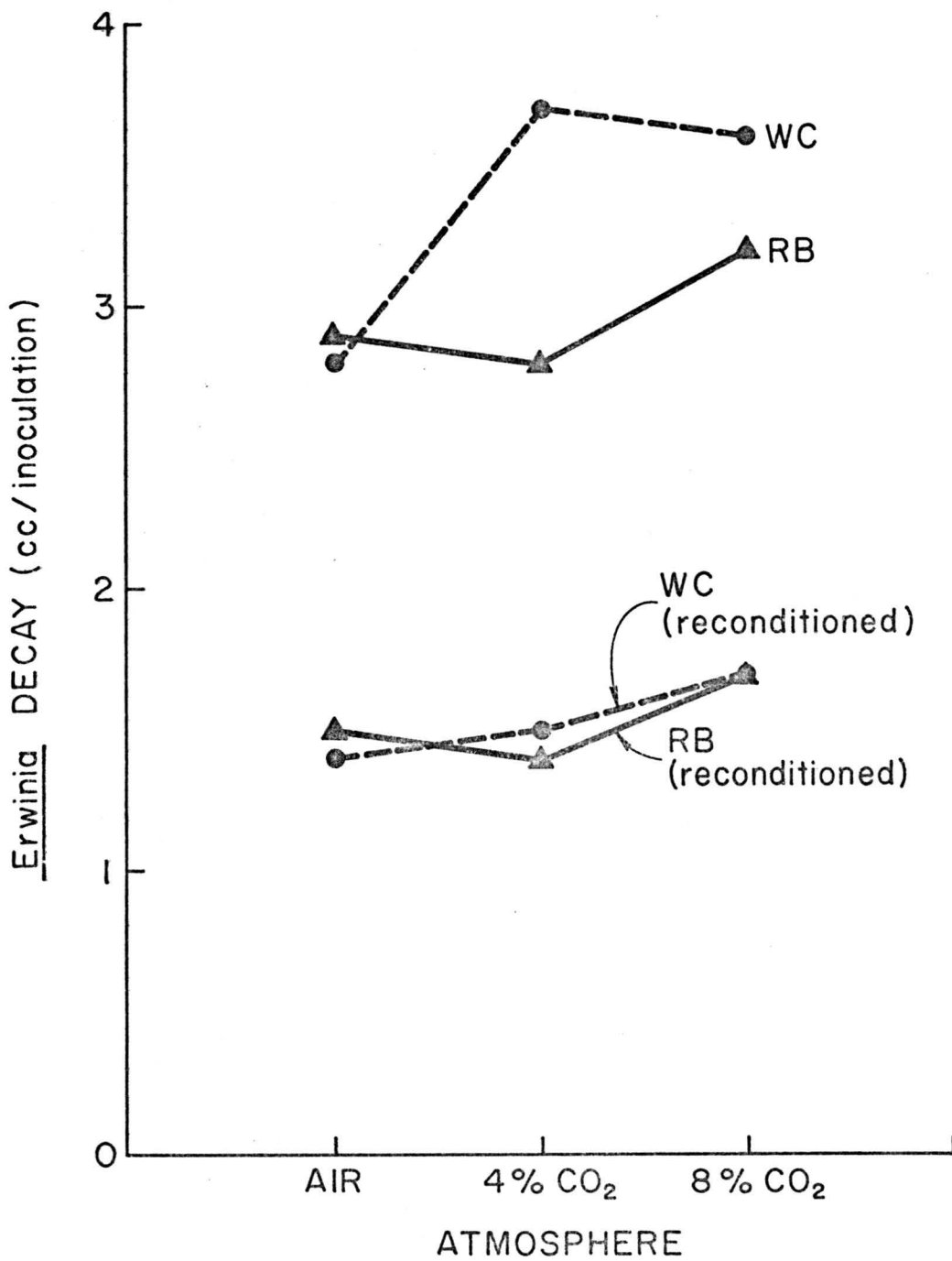


Figure 8. Effect of 32° F storage, CO<sub>2</sub>, and reconditioning on Erwinia decay of Russet Burbank and WC230-14 tubers after 175 days.

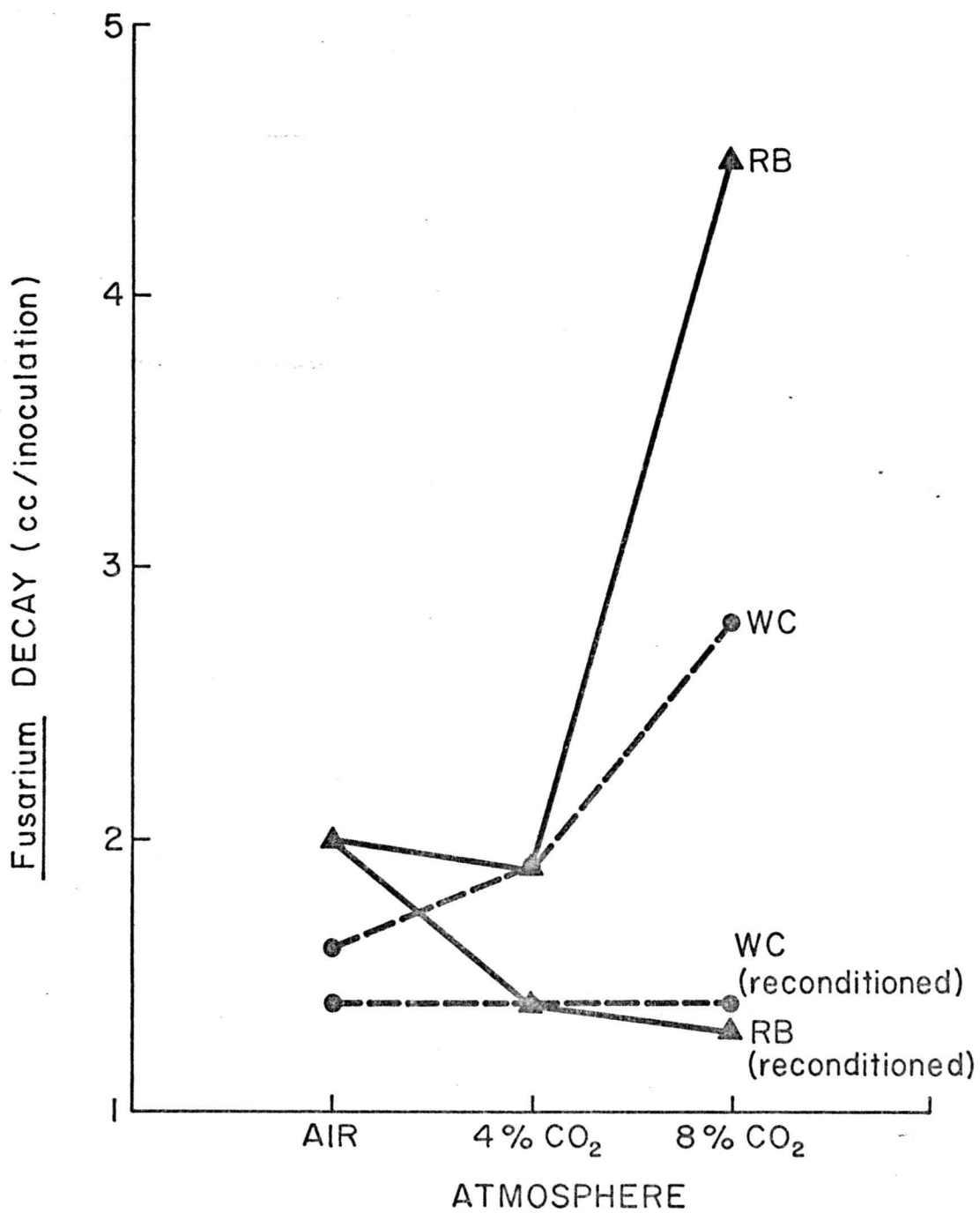


Figure 9. Effect of 32° F storage, CO<sub>2</sub>, and reconditioning on Fusarium decay of Russet Burbank and WC230-14 tubers after 175 days.

reconditioning (Table 8). Total sugars also decreased but in the main this was due to a reduction in sucrose, particularly with WC230-14 in which reconditioning did not decrease the % reducing sugars.

Additional support for the sucrose-permeability-decay relationship came from a comparison of the rate of Erwinia and Fusarium decay of either variety after 134 days of storage at 32° F in either air, 4 or 8% CO<sub>2</sub> with the rate of breakdown after 175 days of storage. The Erwinia results are shown in Fig. 10 and Fusarium in Fig. 11. It is clear that the rate of Erwinia decay was more rapid after 175 days irrespective of whether the tubers had been stored in air, 4 or 8% CO<sub>2</sub>. However, with Fusarium, while the increased rate of decay was apparent following 175 days storage in air or 4% CO<sub>2</sub>, it was much more noticeable when the tubers were stored in 8% CO<sub>2</sub>. Again, % sucrose and cell membrane permeability were consistently increased by the additional storage time (Table 9). Reducing sugars did not show a consistent trend and occasionally decreased.

Additional but less convincing support for the sucrose-permeability-decay relationship was obtained from a comparison of the rate of Erwinia decay of either variety after 175 days of storage at 32° F in air, 4 or 8% CO<sub>2</sub> with the rate of decay following storage at 41° F for the same time and in the same atmospheres (Fig. 12). Clearly, more rapid Erwinia decay of both varieties followed 32° F storage in all atmospheres. Table 10 also shows that sucrose and cell membrane permeability were higher following 32° F storage concomittant with the

Table 8. Influence of reconditioning following 175 days storage at 32° F on the rate of Fusarium and Erwinia decay and simultaneous changes in permeability and sugars.

<u>Fusarium</u> Decay <sup>1/</sup>					<u>Erwinia</u> Decay <sup>1/</sup>					Permeability <sup>2/</sup>				
	% CO <sub>2</sub>	Before	After	% <sup>3/</sup>		% CO <sub>2</sub>	Before	After	%		% CO <sub>2</sub>	Before	After	%
R. Burbank	0	2.0	2.0	0	R. Burbank	0	2.9	1.5	-48	R. Burbank	0	264	46	-83
	4	1.9	1.4	-26		4	2.8	1.4	-50		4	251	85	-66
	8	4.5	1.3	-71		8	3.2	1.7	-47		8	295	155	-47
WC230-14	0	1.6	1.4	-13	WC230-14	0	2.8	1.4	-50	WC230-14	0	541	85	-84
	4	1.9	1.4	-26		4	3.7	1.5	-59		4	574	131	-77
	8	2.8	1.4	-50		8	3.6	1.7	-53		8	604	218	-64
% Sucrose <sup>4/</sup>					% Reducing Sugar <sup>4/</sup>					% Total Sugar <sup>4/</sup>				
	% CO <sub>2</sub>	Before	After	%		% CO <sub>2</sub>	Before	After	%		% CO <sub>2</sub>	Before	After	%
R. Burbank	0	1.34	.16	-88	R. Burbank	0	1.41	.43	-70	R. Burbank	0	2.82	.60	-79
	4	1.66	.33	-80		4	1.65	.87	-47		4	3.40	1.21	-64
	8	1.86	.50	-73		8	1.51	1.31	-13		8	3.46	1.84	-47
WC230-14	0	1.20	.02	-98	WC230-14	0	1.62	1.75	0	WC230-14	0	2.88	1.76	-39
	4	1.71	.30	-82		4	1.59	1.52	-4		4	3.38	1.83	-46
	8	2.19	.51	-77		8	1.87	1.79	-4		8	4.17	2.33	-44

<sup>1/</sup> cc. of tissue destroyed per inoculation

<sup>2/</sup> micromhos per hour

<sup>3/</sup> % =  $(\frac{\text{after-before}}{\text{before}}) \times 100$

<sup>4/</sup> Fresh Weight Basis

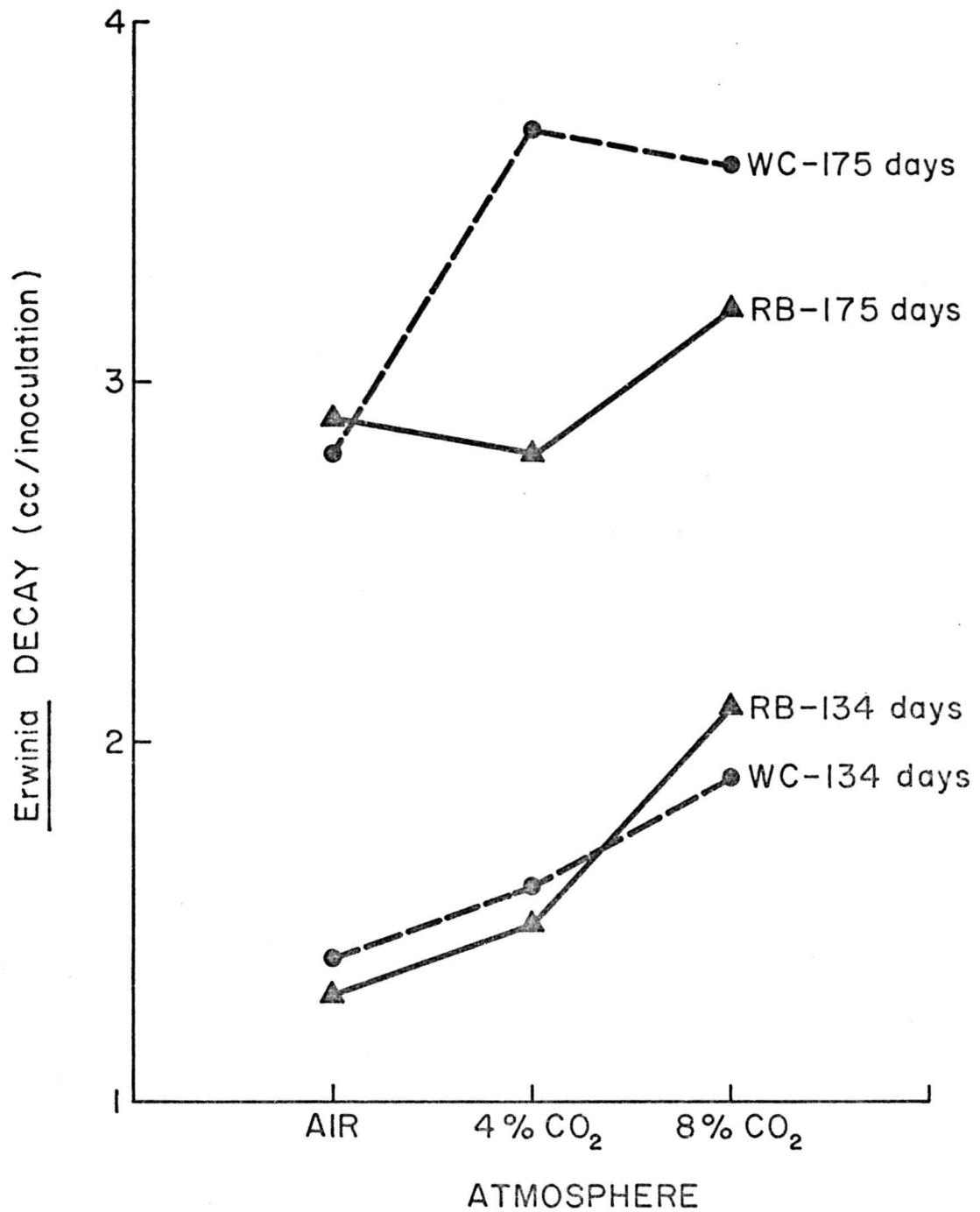


Figure 10. Effect of time in storage and CO<sub>2</sub> on Erwinia decay of Russet Burbank and WC230-14 tubers under 32°F storage.

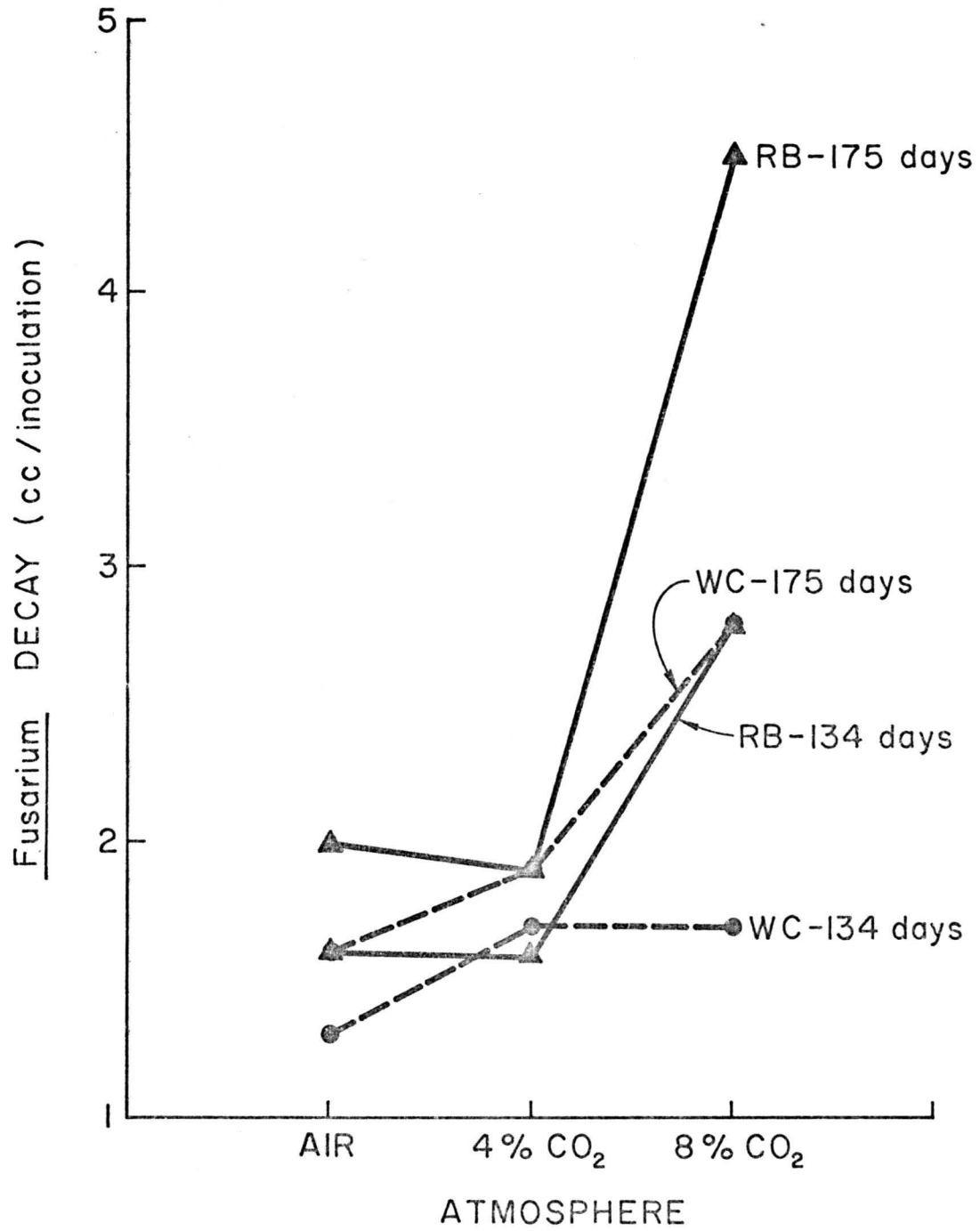


Figure 11. Effect of time in storage and CO<sub>2</sub> on Fusarium decay of Russet Burbank and WC230-14 tubers under 32°F storage.

Table 9. Influence of storage time at 32°F, 134 days compared to 175 days, on the rate of Erwinia and Fusarium decay and the simultaneous changes in permeability and sugars.

<u>Fusarium</u> Decay <sup>1/</sup>					<u>Erwinia</u> Decay <sup>1/</sup>					Permeability <sup>2/</sup>				
	% CO <sub>2</sub>	134 D	175 D	% <sup>3/</sup>		% CO <sub>2</sub>	134 D	175 D	%		% CO <sub>2</sub>	134 D	175 D	%
R. Burbank	0	1.6	2.0	+25	R. Burbank	0	1.3	2.9	+123	R. Burbank	0	188	264	+40
	4	1.6	1.9	+19		4	1.5	2.8	+ 87		4	206	251	+22
	8	2.8	4.5	+61		8	2.1	3.2	+ 52		8	225	295	+31
WC230-14	0	1.3	1.6	+23	WC230-14	0	1.4	2.8	+100	WC230-14	0	275	541	+97
	4	1.7	1.9	+12		4	1.6	3.7	+131		4	360	574	+59
	8	1.7	2.8	+65		8	1.9	3.6	+ 89		8	518	604	+17

% Sucrose <sup>4/</sup>					% Reducing Sugar <sup>4/</sup>					% Total Sugar <sup>4/</sup>				
	% CO <sub>2</sub>	134 D	175 D	%		% CO <sub>2</sub>	134 D	175 D	%		% CO <sub>2</sub>	134 D	175 D	%
R. Burbank	0	1.18	1.34	+14	R. Burbank	0	1.84	1.41	-23	R. Burbank	0	3.08	2.82	- 8
	4	1.59	1.66	+ 4		4	1.48	1.65	+11		4	3.15	3.40	+ 8
	8	1.70	1.86	+ 9		8	1.29	1.51	+17		8	3.09	3.46	+12
WC230-14	0	.83	1.20	+45	WC230-14	0	1.91	1.62	-15	WC230-14	0	2.78	2.88	+ 4
	4	.95	1.71	+80		4	2.10	1.59	-24		4	3.11	3.38	+ 9
	8	1.25	2.19	+75		8	1.99	1.87	- 5		8	3.28	4.17	+27

<sup>1/</sup> cc. of tissue destroyed per inoculation

<sup>2/</sup> micromhos per hour

<sup>3/</sup> % =  $(\frac{175 \text{ days} - 134 \text{ days}}{134 \text{ days}}) \times 100$

<sup>4/</sup> Fresh Weight Basis

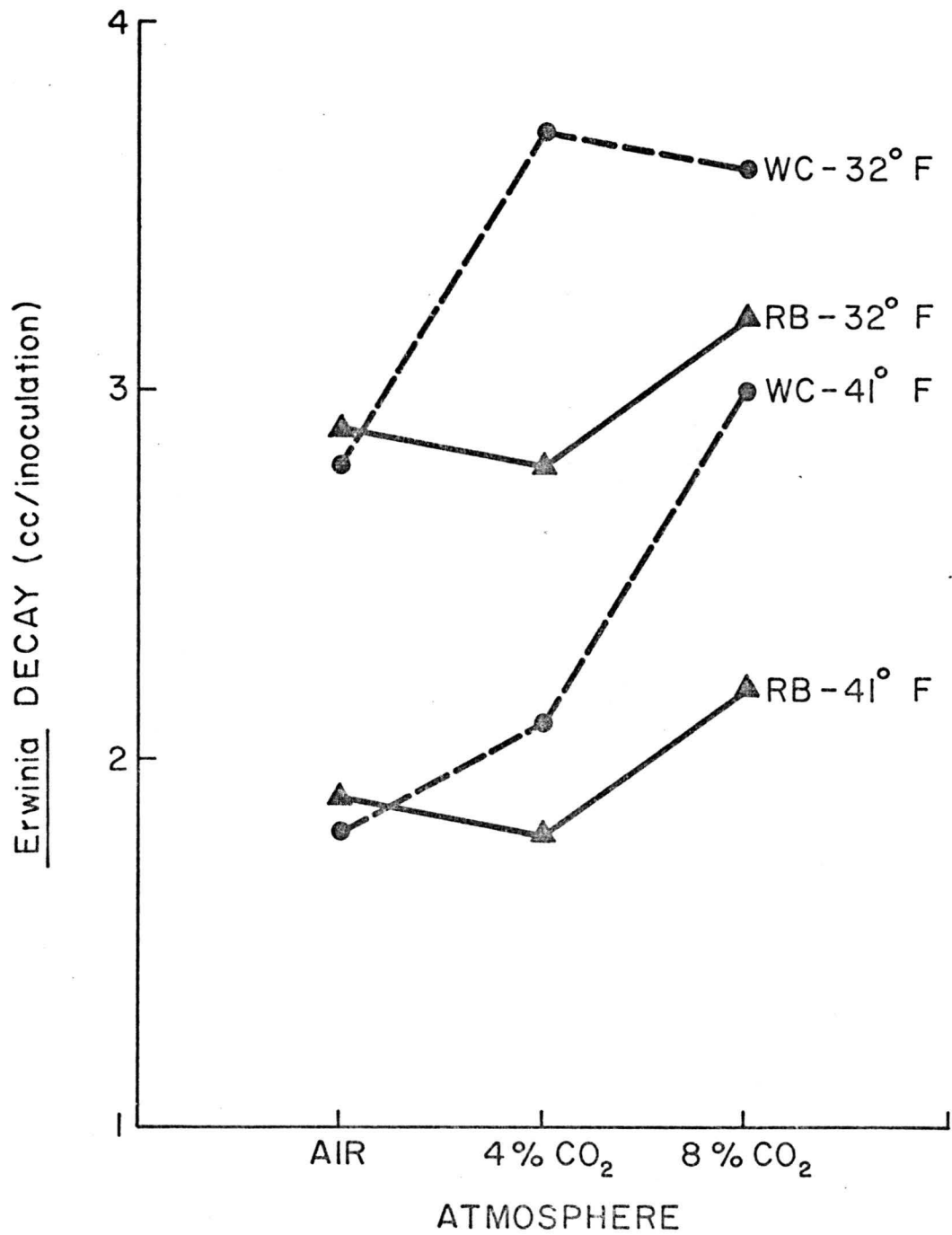


Figure 12. Effect of 41° F or 32° F storage temperature and CO<sub>2</sub> on the rate of Erwinia decay on Russet Burbank and WC230-14 tubers after 175 days of storage.

Table 10. A comparison of 32° with 41° F storage (after 175 days) on tuber decay by Erwinia and Fusarium and concomittant changes in sugars and cell membrane permeability.

<u>Fusarium</u> Decay <sup>1/</sup>					<u>Erwinia</u> Decay <sup>1/</sup>					Permeability <sup>2/</sup>				
	% CO <sub>2</sub>	32°	41°	% <sup>3/</sup>		% CO <sub>2</sub>	32°	41°	%		% CO <sub>2</sub>	32°	41°	%
R. Burbank	0	2.0	2.5	-20	R. Burbank	0	2.9	1.9	+34	R. Burbank	0	264	75	+252
	4	1.9	2.7	-30		4	2.8	1.8	+55		4	251	82	+206
	8	4.5	2.5	+80		8	3.2	2.2	+45		8	295	108	+173
WC230-14	0	1.6	1.4	+14	WC230-14	0	2.8	1.8	+55	WC230-14	0	541	137	+294
	4	1.9	1.4	+36		4	3.7	2.1	+76		4	574	158	+263
	8	2.8	1.6	+75		8	3.6	3.0	+20		8	604	247	+ 59

% Sucrose <sup>4/</sup>					% Reducing Sugar <sup>4/</sup>					% Total Sugar <sup>4/</sup>				
	% CO <sub>2</sub>	32°	41°	%		% CO <sub>2</sub>	32°	41°	%		% CO <sub>2</sub>	32°	41°	%
R. Burbank	0	1.34	.06	+2133	R. Burbank	0	1.41	.47	+200	R. Burbank	0	2.82	.53	+432
	4	1.66	.14	+1085		4	1.65	.79	+108		4	3.40	.94	+261
	8	1.86	.34	+ 447		8	1.51	.81	+ 86		8	3.46	1.16	+198
WC230-14	0	1.20	.30	+ 300	WC230-14	0	1.62	.92	+ 76	WC230-14	0	2.88	1.23	+134
	4	1.71	.66	+ 159		4	1.59	1.07	+ 49		4	3.38	1.76	+ 92
	8	2.19	1.63	+ 34		8	1.87	.89	+110		8	4.17	2.60	+ 60

<sup>1/</sup> cc. of tissue destroyed per inoculation

<sup>2/</sup> micromhos per hour

<sup>3/</sup> % =  $(\frac{32^\circ - 41^\circ}{41^\circ}) \times 100$

<sup>4/</sup> Fresh Weight Basis

more rapid Erwinia decay. However, reducing sugar content was also higher following 32° F storage compared to storage at 41° F thus confounding the sucrose-permeability-decay relationship.

The apparent relationship between permeability and decay, and between sucrose and decay was subjected to further statistical analysis. Using the averages of four observations made during the 6 months and combining the data for both varieties, a linear regression analysis gave a highly significant linear correlation coefficient ( $r=0.80$ ) between Erwinia decay and cell membrane permeability (Fig. 13). A similar linear regression analysis also gave a highly significant correlation coefficient ( $r=0.88$ ) between Erwinia decay and % sucrose (Fig. 14). No significant linear correlation coefficients were obtained between Fusarium decay and cell membrane permeability ( $r=0.10$ ) or between Fusarium decay and % sucrose ( $r=0.36$ ).

A multiple regression analysis combining permeability and sucrose in relation to Erwinia decay gave a significant correlation coefficient ( $R=0.89$ ) (Table 11). Thus, an increase in the rate of tuber decay by Erwinia is associated with an increase in sucrose level and permeability of the cell membrane or vice versa. Taken together, sucrose and permeability changes accounted for 80% ( $R^2$ ) of the difference in the rate of Erwinia decay observed between the various treatments.

A number of other linear regression analyses between other variables and Erwinia and Fusarium were also run. The correlation

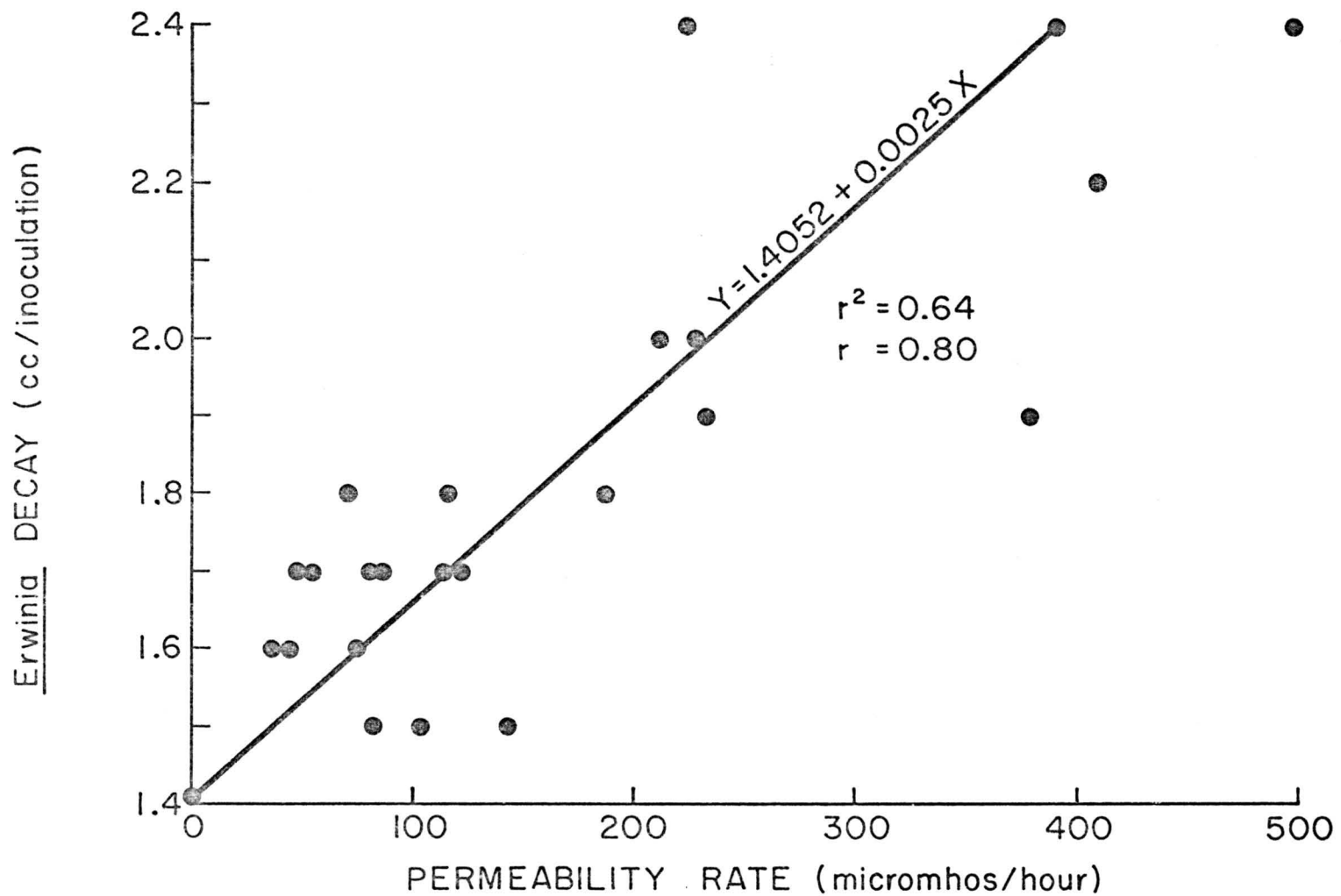


Figure 13. Linear regression between Erwinia decay and cell membrane permeability of Russet Burbank and WC230-14 tubers direct from storage and following reconditioning (average of four observations).

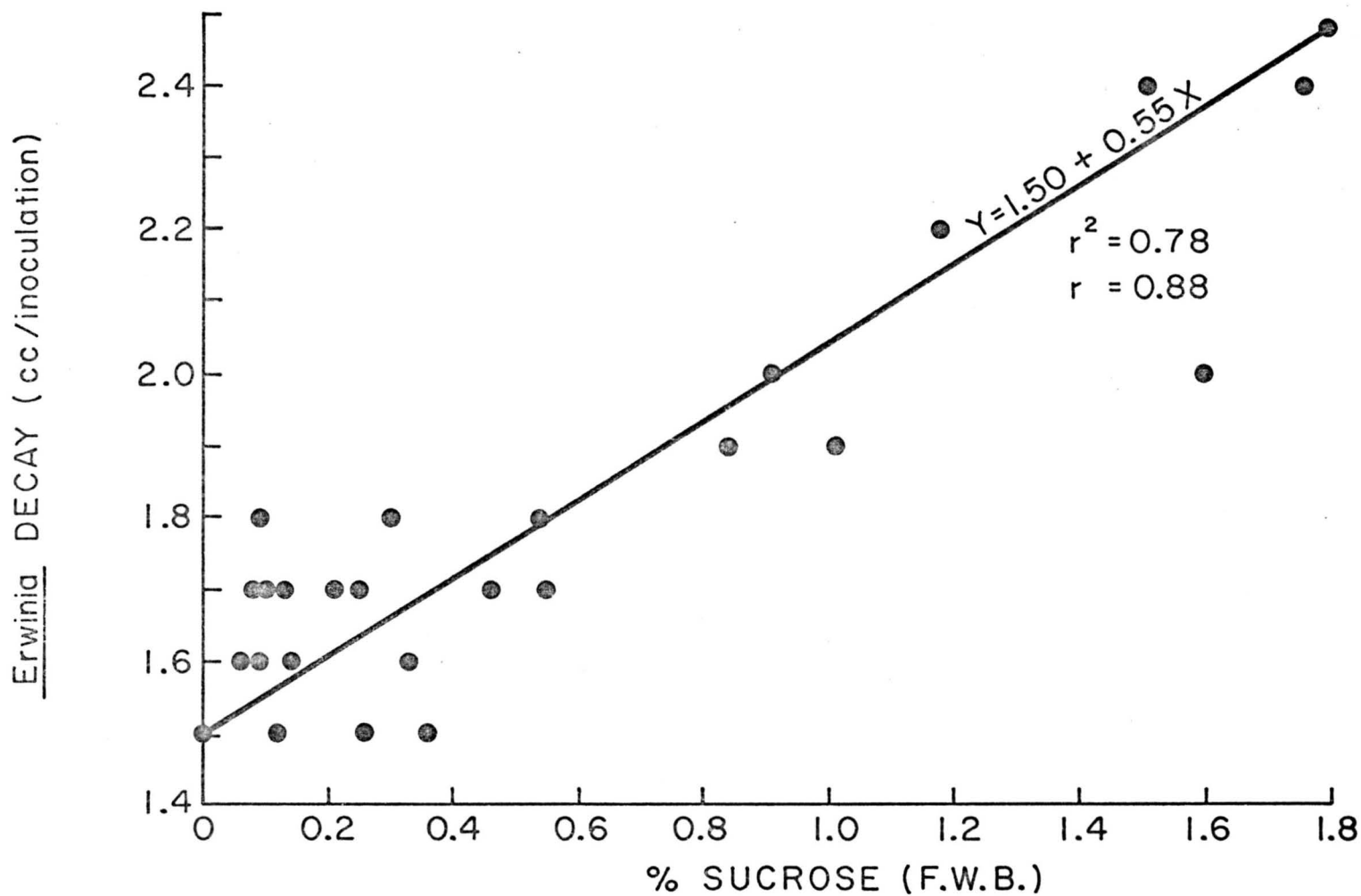


Figure 14. Linear regression between Erwinia decay and sucrose content of Russet Burbank and WC230-14 tubers direct from storage and following reconditioning (average of four observations).

Table 11. Correlations between disease decay and permeability or sugars (based on an average of the four observation dates during the storage season).

2-Variable Linear Regression					
Regression Components		$r^2$	r	Significance 1%	
Y	X				
Fusarium	Permeability	0.01	+0.10	NS	
"	Free Glucose	0.05	+0.22	NS	
"	Free Fructose	0.03	+0.17	NS	
"	Total Reducing Sugars	0.04	+0.20	NS	
"	Sucrose	0.13	+0.36	NS	
"	Total Sugars	0.02	+0.14	NS	
Erwinia	Permeability	0.64	+0.80	SIG	
"	Free Glucose	0.26	+0.51	NS	
"	Free Fructose	0.25	+0.50	NS	
"	Total Reducing Sugars	0.27	+0.52	NS	
"	Sucrose	0.78	+0.88	SIG	
"	Total Sugars	0.59	+0.77	SIG	
Multiple Linear Regression					
Y	X <sub>1</sub>	X <sub>2</sub>	R <sup>2</sup>	R	
Erwinia	Permeability	Sucrose	0.80	0.89	SIG

coefficients obtained and those discussed above are summarized in Table 11. Other than the highly significant correlation coefficients between Erwinia and cell membrane permeability and sucrose, none of the other coefficients were significant. The significance of the correlation coefficient between Erwinia and total sugars was of course mostly due to the sucrose content.

## VI. CONCLUSIONS

Compared to 41<sup>o</sup>F, storage at 32<sup>o</sup>F increased the tuber sugar content and cell membrane permeability and predisposed the tubers to more rapid decay. As storage time increased at either temperature, free fructose and free glucose usually leveled off or declined while sucrose, permeability and disease susceptibility increased.

Generally, increasing CO<sub>2</sub> in the storage atmosphere increased the sucrose, free glucose, and free fructose content of the tubers and the rate of electrolyte loss from tissue sections. Increasing CO<sub>2</sub>, mainly at 32<sup>o</sup>F, also increased the rate of Erwinia and Fusarium tuber decay. Increasing susceptibility became more evident with increasing time in storage.

WC230-14 synthesized more free fructose and free glucose while exhibiting higher cell membrane permeability than Russet Burbank. WC230-14 synthesized more sucrose at 41<sup>o</sup>F than Russet Burbank, but the reverse was true at 32<sup>o</sup>F.

Reconditioning generally reversed the adverse effects resulting from storage at 32<sup>o</sup>F in elevated CO<sub>2</sub> levels. Russet Burbank and WC230-14 tubers both decreased in cell membrane permeability, sucrose content and the rate of Erwinia and Fusarium decay after reconditioning. However during reconditioning, WC230-14 did not have the enzymatic capability to decrease the reducing sugar concentrations.

Compared to Russet Burbank, WC230-14 was more resistant to Fusarium decay but less resistant to Erwinia decay after 175 days in storage. Combining both varieties and the four observation dates gave a significant positive correlation between the rate of Erwinia decay and either sucrose concentration or cell membrane permeability. Combining sucrose and permeability in a multiple regression analysis in relation to Erwinia decay gave a higher correlation coefficient than either factor alone. Approximately 80% of the variation in the rate of Erwinia decay could be explained on the differences in sucrose concentration and membrane permeability.

No significant correlations were found between the rate of Fusarium decay and sugar concentrations or cell membrane permeability. This observation indicates that other factors not measured in this study influence the rate of Fusarium decay.

In this study, one objective was to determine whether some measurable parameter or parameters could be used to predict differences between varieties in the rate of tuber decay by the two common storage pathogens. The two varieties of potatoes selected for study did not differ greatly in the rate of Erwinia decay even though WC230-14 did exhibit higher cell membrane permeability rates and somewhat higher sucrose concentrations. However, the magnitude of the differences in permeability and sucrose between the varieties was much less than the magnitude of differences which were developed between storage treatments and which were used in the

linear regression analyses. Thus, simply measuring sucrose and permeability would not positively identify a varietal weakness in response to soft rot organisms. However, if proper precautions are taken to insure uniform growing and storage conditions and sufficient tuber numbers are used to permit statistical evaluations, sucrose and permeability measurements would be helpful to identify potential weaknesses. Also, since both of these parameters are tremendously responsive to storage temperatures and atmospheres, and varieties may differ in response to these, variety comparisons should be made following more than one storage environment.

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APPENDIX

Table A1. The influence of storage time, temperature, atmosphere, and reconditioning on the free glucose content of potato tissue. Values shown are percent free glucose (Fresh Weight Basis).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	.21 <sup>g</sup> <sup>2/</sup>	.15 <sup>e</sup>	29	.21 <sup>f</sup>	.12 <sup>d</sup>	43	.23 <sup>e</sup>	.04 <sup>d</sup>	83	.21 <sup>e</sup>	.05 <sup>e</sup>	76	.22	.09	58
		4%	.30 <sup>fg</sup>	.17 <sup>e</sup>	43	.42 <sup>e</sup>	.18 <sup>d</sup>	57	.33 <sup>d</sup>	.07 <sup>d</sup>	79	.36 <sup>d</sup>	.05 <sup>e</sup>	86	.35	.12	66
		8%	.38 <sup>ef</sup>	.29 <sup>de</sup>	24	.53 <sup>cde</sup>	.18 <sup>d</sup>	66	.43 <sup>d</sup>	.11 <sup>d</sup>	74	.36 <sup>d</sup>	.06 <sup>e</sup>	83	.43	.16	62
41°	WC230-14	Air	.30 <sup>fg</sup>	.36 <sup>cd</sup>	0	.46 <sup>de</sup>	.40 <sup>bc</sup>	13	.39 <sup>d</sup>	.34 <sup>bc</sup>	13	.46 <sup>cd</sup>	.40 <sup>bc</sup>	13	.40	.38	10
		4%	.41 <sup>de</sup>	.48 <sup>bc</sup>	0	.55 <sup>bcd</sup>	.51 <sup>ab</sup>	7	.53 <sup>c</sup>	.38 <sup>abc</sup>	28	.51 <sup>bc</sup>	.36 <sup>c</sup>	29	.50	.43	16
		8%	.59 <sup>b</sup>	.56 <sup>ab</sup>	5	.66 <sup>b</sup>	.52 <sup>ab</sup>	21	.53 <sup>c</sup>	.42 <sup>abc</sup>	21	.41 <sup>d</sup>	.41 <sup>bc</sup>	0	.55	.48	12
32°	R. Burbank	Air	.51 <sup>bc</sup>	.21 <sup>de</sup>	59	.85 <sup>a</sup>	.16 <sup>d</sup>	81	.79 <sup>a</sup>	.16 <sup>d</sup>	80	.61 <sup>a</sup>	.12 <sup>de</sup>	80	.69	.16	75
		4%	.48 <sup>cd</sup>	.28 <sup>de</sup>	42	.65 <sup>bc</sup>	.32 <sup>c</sup>	51	.63 <sup>b</sup>	.35 <sup>bc</sup>	44	.60 <sup>ab</sup>	.29 <sup>cd</sup>	52	.59	.31	47
		8%	.29 <sup>fg</sup>	.30 <sup>de</sup>	0	.54 <sup>cde</sup>	.41 <sup>bc</sup>	24	.56 <sup>bc</sup>	.30 <sup>c</sup>	46	.63 <sup>a</sup>	.35 <sup>c</sup>	44	.51	.34	29
32°	WC230-14	Air	.74 <sup>a</sup>	.61 <sup>ab</sup>	18	.79 <sup>a</sup>	.53 <sup>ab</sup>	33	.79 <sup>a</sup>	.51 <sup>a</sup>	35	.63 <sup>a</sup>	.60 <sup>ab</sup>	5	.74	.56	23
		4%	.74 <sup>a</sup>	.68 <sup>a</sup>	8	.78 <sup>a</sup>	.61 <sup>a</sup>	22	.80 <sup>a</sup>	.51 <sup>a</sup>	36	.63 <sup>a</sup>	.60 <sup>ab</sup>	5	.74	.60	18
		8%	.74 <sup>a</sup>	.70 <sup>a</sup>	5	.80 <sup>a</sup>	.51 <sup>ab</sup>	36	.82 <sup>a</sup>	.47 <sup>ab</sup>	43	.62 <sup>a</sup>	.67 <sup>a</sup>	0	.75	.59	21

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62°F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.

Table A2. The influence of storage time, temperature, atmosphere, and reconditioning on the free fructose content of potato tissue. Values shown are percent free fructose (Fresh Weight Basis).

Temp.	Variety	Atm.	48 Days <sup>1/</sup>			95 Days			134 Days			175 Days			Average		
			A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
41°	R. Burbank	Air	.25 <sup>c</sup> <sup>2/</sup>	.23 <sup>ef</sup>	8	.25 <sup>d</sup>	.18 <sup>d</sup>	28	.29 <sup>g</sup>	.05 <sup>g</sup>	83	.26 <sup>d</sup>	.10 <sup>d</sup>	62	.26	.14	45
		4%	.29 <sup>c</sup>	.21 <sup>f</sup>	28	.42 <sup>cd</sup>	.28 <sup>cd</sup>	33	.38 <sup>fg</sup>	.14 <sup>fg</sup>	63	.43 <sup>cd</sup>	.12 <sup>d</sup>	72	.38	.19	49
		8%	.54 <sup>bc</sup>	.32 <sup>ef</sup>	41	.58 <sup>bcd</sup>	.27 <sup>cd</sup>	53	.51 <sup>ef</sup>	.25 <sup>efg</sup>	51	.45 <sup>cd</sup>	.15 <sup>cd</sup>	67	.52	.25	53
41°	WC230-14	Air	.27 <sup>c</sup>	.38 <sup>def</sup>	0	.44 <sup>cd</sup>	.41 <sup>bcd</sup>	7	.43 <sup>fg</sup>	.32 <sup>defg</sup>	26	.47 <sup>cd</sup>	.48 <sup>b</sup>	0	.40	.40	8
		4%	.52 <sup>bc</sup>	.44 <sup>de</sup>	15	.57 <sup>bcd</sup>	.51 <sup>bc</sup>	11	.62 <sup>de</sup>	.44 <sup>cdef</sup>	29	.56 <sup>c</sup>	.41 <sup>bc</sup>	27	.57	.45	21
		8%	.77 <sup>ab</sup>	.56 <sup>cd</sup>	27	1.14 <sup>a</sup>	.41 <sup>bcd</sup>	64	.78 <sup>cd</sup>	.58 <sup>bcde</sup>	26	.48 <sup>cd</sup>	.48 <sup>b</sup>	0	.79	.51	29
32°	R. Burbank	Air	.74 <sup>ab</sup>	.34 <sup>ef</sup>	54	1.12 <sup>a</sup>	.39 <sup>bcd</sup>	65	1.06 <sup>b</sup>	.33 <sup>defg</sup>	69	.80 <sup>b</sup>	.32 <sup>bcd</sup>	60	.93	.35	62
		4%	.49 <sup>bc</sup>	.32 <sup>ef</sup>	35	.99 <sup>ab</sup>	.48 <sup>bc</sup>	52	.85 <sup>c</sup>	.61 <sup>abcd</sup>	28	1.06 <sup>ab</sup>	.58 <sup>b</sup>	45	.85	.50	40
		8%	.57 <sup>bc</sup>	.39 <sup>def</sup>	32	.81 <sup>abc</sup>	.56 <sup>b</sup>	31	.73 <sup>cd</sup>	.70 <sup>abc</sup>	4	.88 <sup>b</sup>	.97 <sup>a</sup>	0	.75	.66	17
32°	WC230-14	Air	1.02 <sup>a</sup>	.69 <sup>bc</sup>	32	1.03 <sup>ab</sup>	.89 <sup>a</sup>	14	1.12 <sup>b</sup>	.83 <sup>ab</sup>	26	.99 <sup>b</sup>	1.15 <sup>a</sup>	0	1.04	.89	18
		4%	1.09 <sup>a</sup>	.78 <sup>ab</sup>	28	1.04 <sup>ab</sup>	1.02 <sup>a</sup>	2	1.30 <sup>a</sup>	.93 <sup>a</sup>	28	.96 <sup>b</sup>	.92 <sup>a</sup>	4	1.10	.91	16
		8%	1.04 <sup>a</sup>	.91 <sup>a</sup>	13	1.14 <sup>a</sup>	.83 <sup>a</sup>	27	1.15 <sup>ab</sup>	.76 <sup>abc</sup>	34	1.25 <sup>a</sup>	1.13 <sup>a</sup>	10	1.15	.91	21

<sup>1/</sup> Days in storage; A = tubers direct from storage; B = tubers reconditioned 14 days at 62° F; and C = % decrease following reconditioning.

<sup>2/</sup> Duncan's multiple range test - Values in the same column bearing the same letter do not differ at the 5% level of significance.