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GAMMA-RAY SPROUT INHIBITION OF POTATOES

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CONTRACT RESEARCH PROGRESS REPORT

QUARTERMASTER FOOD AND CONTAINER INSTITUTE
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Title of Contract: Gamma-Ray Sprout Inhibition of Potatoes

SUMMARY

Weight losses during storage for irradiated and control Sebago and Russet Rural variety potatoes have been determined as a function of radiation dose, temperature of storage, and duration of storage. The data for the two varieties and for the Idaho-grown Russet Burbanks studied during the summer of 1955 differ appreciably. In the studies on Russet Rural variety tubers, weight loss for a given storage decreased with increased dosage up to 15,000 to 25,000 rep, whereas the reverse effect was observed with the Sebago variety tubers. Experimental results indicate that this difference is due to characteristics of the varieties rather than the time of irradiation relative to the life cycle of the tuber.

The weight-loss data seem to indicate that the low doses of radiation, which have been found to be sufficient for sprout inhibition, cause less increase in weight loss relative to the control than higher doses. As the higher doses are also observed to promote more rapid spoilage by rotting, the lowest dose which can be demonstrated to inhibit sprouting seems optimum from the point of view of overall storage properties.

A short experiment was performed in which portions of tubers were irradiated. Irradiating the potato, but not the sprout, did not affect subsequent sprout growth. Irradiating the sprout, but not the tuber, stopped growth altogether. Also, tubers irradiated at the bud end only sprouted from other nonirradiated eyes that would normally be inhibited by growth at the bud end.

I. TECHNICAL OBJECTIVES

Low-dosage gamma irradiation of potatoes has been found to be very successful in preventing sprouting and spoilage of potatoes under storage without the development of undesirable changes. Northern-grown potatoes are available only 8 or 9 months of the year. Because of sprouting followed by rapid deterioration, it usually is not possible to keep potatoes under storage for longer periods. It is believed that desirable types of potatoes can, by irradiation, be made available the year around. This treatment might be particularly useful in increasing the storage life of any type of potato shipped overseas for the armed services.

More specifically, the general technical objective is described below:

A. A study will be made on the effect of low dosages of gamma radiation (approximately 5,000 to 25,000 rep) on at least one white-skinned and one Russet variety potato with the object of determining the dosage needed to inhibit sprouting when stored at 35°, 40°, 50°, 60°, and 80°F with 85% relative humidity.

B. An investigation will be made, using doses of gamma radiation as high as 200,000 rep on the same types of potatoes as studied in (A) above, to determine the effect of overdose.

C. A study will be made of the effect of three different relative humidities and at two storage temperatures during storage on a white-skinned and a Russet variety potato.

D. An evaluation will be made at no less than four scheduled intervals during the storage of the irradiated potatoes that have been stored. The said evaluation shall include:

1. total starch, sucrose, and reducing-sugar content,
2. sprouting and its inhibition,
3. general appearance and texture,
4. interior fleshy region of peeled and sliced potatoes for decay, black heart, blackening, and other manifestations of enzyme and/or microbial action, and
5. loss in weight, to be determined and subdivided into combined respiration and transpiration loss and loss due to sprouts.

E. As time allows, a limited study will be made on the effects of wound healing, with special emphasis on formation of cork cambium, cellular organization, and structure.

F. A quantitative respiration study will be conducted on at least a white-skinned variety and a selected Russet variety of potatoes.

G. The effect of gamma radiation on the activity of specific enzymes involved in potato respiration will be investigated. This will be aimed at understanding the inhibition of enzyme activity as reflected by changes in starch content, total and reducing-sugar content, and color change, allowing for extended storage life of the potato.

H. A study will be made of the growth hormone and inhibitors in and around the eyes of irradiated and control potatoes to determine whether or not gamma-ray-induced inhibition of potato sprouting is caused by an increase in the quantity of sprout inhibitors.

I. A study will be conducted to determine the incidence of common storage rot in irradiated potatoes. This will include inoculation and storage studies utilizing common potato-rotting bacteria and fungi.

J. Samples of potatoes described under (A) will be made available for acceptance testing by personnel of QMF and CI.

II. WEIGHT LOSS IN IRRADIATED POTATOES STORED AT VARIOUS TEMPERATURES

Sebago and Russet potatoes received from Michigan State University were irradiated on or about December 7, 1955, and were immediately placed with appropriate controls in various constant-temperature rooms at The University of Michigan Food Service Building. They were stored in special tared crates to minimize handling. The potatoes were then weighed about twice a month in an effort to gain information about the rate of weight loss and the total amount of weight lost by irradiated and nonirradiated potatoes. After a time it became apparent that potatoes which rotted early would infect sound potatoes if left in the crate. In order to avoid this happening, rotting potatoes were separated, placed in bags, and kept with the rest of the sample. This was done so that a percentage weight loss of the entire sample could be determined. In addition, the sound potatoes were weighed alone to determine the weight percentage of

potatoes that were still usable. The number of potatoes removed was also recorded, and the number percentage of sound potatoes was calculated.

Tables I-III contain total weight-loss data, i.e., with the rotten potatoes included. Table I and Fig. 1 show the weight loss for Sebagos given various doses and stored at 45°F. With increased irradiation, there is an increase in weight loss. In each case, 15 kilorep seem to promote more weight loss than other low doses of radiation, while 10 kilorep seem to promote only slightly more loss than the controls.

Table II and Fig. 2 show the weight loss of Russets treated with various doses of radiation and stored at 45°F. Initially all dosages appear to cause increased weight loss, but after three or four months the lower dosages show less weight loss than the controls. Higher doses, on the other hand, cause weight losses greater than the controls.

The region of 10 kilorep seems to be the most advantagous for decreasing weight loss of this variety of potatoes at this storage temperature. However, 15-kilorep irradiated potatoes show nearly as great a loss as the nonirradiated potatoes, while potatoes irradiated with 20 and 25 kilorep show a somewhat smaller weight loss. This same type of variation with dosage is also indicated in the Sebago potatoes, although in this case all irradiated potatoes lost more weight than the nonirradiated potatoes.

The results discussed above suggest that radiation may act in two different ways. Perhaps the early decrease in weight loss with increase in irradiation is due to action on the cells which slows down metabolism (see respiration). The sudden rise in weight loss, observed at 15 kilorep, may be due to rotting of the tissue. Rotting occurs with increasing frequency at higher doses of radiation. The higher doses appear to cause the potatoes to be more vulnerable to fungi and bacteria. The second apparent dip in the curve may be due to a reduction of the number of surface infective organisms at the time of irradiation.

If these speculations are correct, the peak at 15 kilorep could be a critical point where decreases in water loss no longer occur and killing of infecting organisms is not yet effective, but where vulnerability to infections is beginning to become prominent.

Table III and Figs. 3-6 show the differences between potatoes irradiated with 15 kilorep and control potatoes stored at 35°, 55°, 65°, and 78°F.

In both Russets and Sebagos the irradiated potatoes lose more weight than the controls after storage at 35°F and less than the controls

TABLE I. WEIGHT LOSSES FOR IRRADIATED SEBAGO POTATOES STORED AT 45°F
(Rotten potatoes included)

Time / Dose	Percentage Weight Loss in Sebagos Since December 7								
	February 16	March 1	March 19	April 2	April 16	May 11	May 22	June 5	June 21
0	7.3	9.1	10.4	11.4	13.0	14.9	15.8	16.8	18.0
5,000	8.5	10.1	11.4	12.9	14.2	16.1	17.0	17.9	19.2
10,000	8.2	9.8	10.7	12.3	13.5	15.4	16.1	17.3	18.6
15,000	10.6	12.6	14.6	15.7	17.6	20.1	21.1	22.7	24.3
20,000	9.4	10.9	12.5	14.1	15.7	17.9	18.9	20.1	21.3
25,000	10.1	12.0	13.8	14.8	16.4	18.9	20.2	20.8	22.7
50,000	11.4	13.2	15.1	17.0	18.9	22.0	23.3	25.2	27.3
100,000	11.8	14.0	15.9	17.9	19.8	25.8	--	27.4	30.2
200,000	12.5	15.3	17.5	20.0	21.9	26.2	--	31.2	34.7

TABLE II. WEIGHT LOSSES FOR IRRADIATED RUSSET RURAL POTATOES STORED AT 45°F
(Rotten potatoes included)

Time / Dose	Percentage Weight Loss in Russets Since December 7								
	February 16	March 1	March 19	April 2	April 16	May 11	May 22	June 5	June 21
0	3.5	6.0	8.5	9.4	10.8	11.1	12.3	12.9	14.1
5,000	4.7	5.7	6.3	7.3	8.2	10.1	10.7	11.3	12.3
10,000	5.1	6.0	6.7	7.3	8.0	8.6	9.2	9.8	10.5
15,000	6.6	7.2	8.5	9.1	9.7	11.3	11.7	12.3	13.6
20,000	6.3	7.3	7.9	8.6	9.2	10.4	11.1	11.7	12.7
25,000	6.4	7.3	7.6	8.5	9.5	10.4	11.0	11.3	12.6
50,000	5.8	7.3	8.0	8.9	9.9	11.8	12.4	13.4	14.7
100,000	6.3	7.6	8.3	9.5	10.8	12.0	13.3	14.6	15.5
200,000	5.8	7.3	8.3	9.6	11.2	13.4	14.7	16.7	18.5

TABLE III. ACCUMULATIVE PERCENTAGE WEIGHT LOSS SINCE DECEMBER 7, 1955, FOR CONTROL AND 15-KILOREP IRRADIATED POTATOES STORED AT VARIOUS TEMPERATURES
(Rotten potatoes included)

Variety	Temp	Treatment \ Time	February 2	February 16	March 1	March 19	April 2	April 16	May 11	May 22	June 5	June 21
Sebago	35°	control	7.2	8.5	9.0	10.3	11.3	12.8	14.0	14.7	16.0	17.2
		15,000	8.1	10.0	14.4	12.8	13.7	15.6	17.8	18.1	20.0	21.2
	55°	control	9.1	11.6	13.4	17.2	19.4	24.0	26.6	27.8	29.7	31.6
		15,000	10.1	12.5	14.4	16.9	19.4	21.9	25.6	26.9	28.1	29.4
	65°	control	12.5	16.9	21.3	27.5	31.9	37.8	44.4	47.5	50.9	55.0
		15,000	14.0	17.4	20.2	23.6	27.4	32.2	37.9	40.4	43.5	46.6
	Room	control	16.3	20.4	26.6	--	38.2	discarded	--	--	--	--
		15,000	18.3	22.5	26.9	--	42.5	discarded	--	--	--	--
Russet	35°	control	4.0	4.3	5.0	5.9	6.2	6.5	7.5	7.5	8.7	9.3
		15,000	3.7	10.3	10.9	11.5	12.1	13.3	14.0	14.3	15.2	15.8
	55°	control	6.6	8.5	10.3	13.1	15.9	18.1	22.2	24.1	25.9	28.1
		15,000	7.6	9.3	10.1	12.2	13.5	16.0	16.4	19.8	21.0	21.9
	65°	control	6.8	10.6	15.0	21.9	27.8	34.4	44.1	49.4	54.1	58.7
		15,000	9.7	11.9	14.4	17.2	21.5	26.6	33.8	37.5	40.1	45.0
	Room	control	13.0	15.7	21.2	--	36.6	discarded	--	--	--	--
		15,000	10.3	12.4	16.1	--	30.2	discarded	--	--	--	--

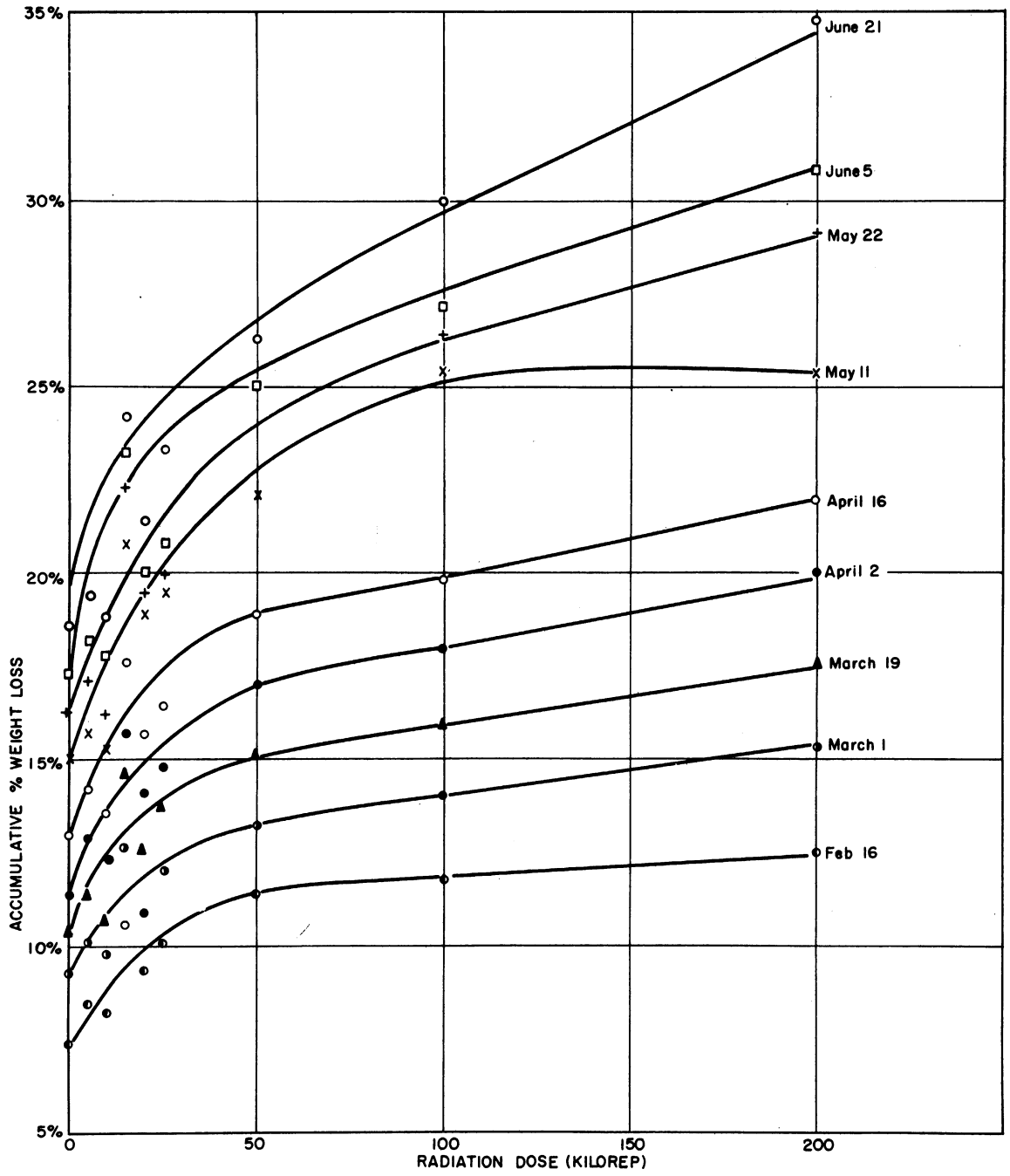

Fig. 1. Accumulative percentage weight loss vs radiation dose for Sebago variety potatoes stored since December 7, at 45°F (rotten potatoes included).

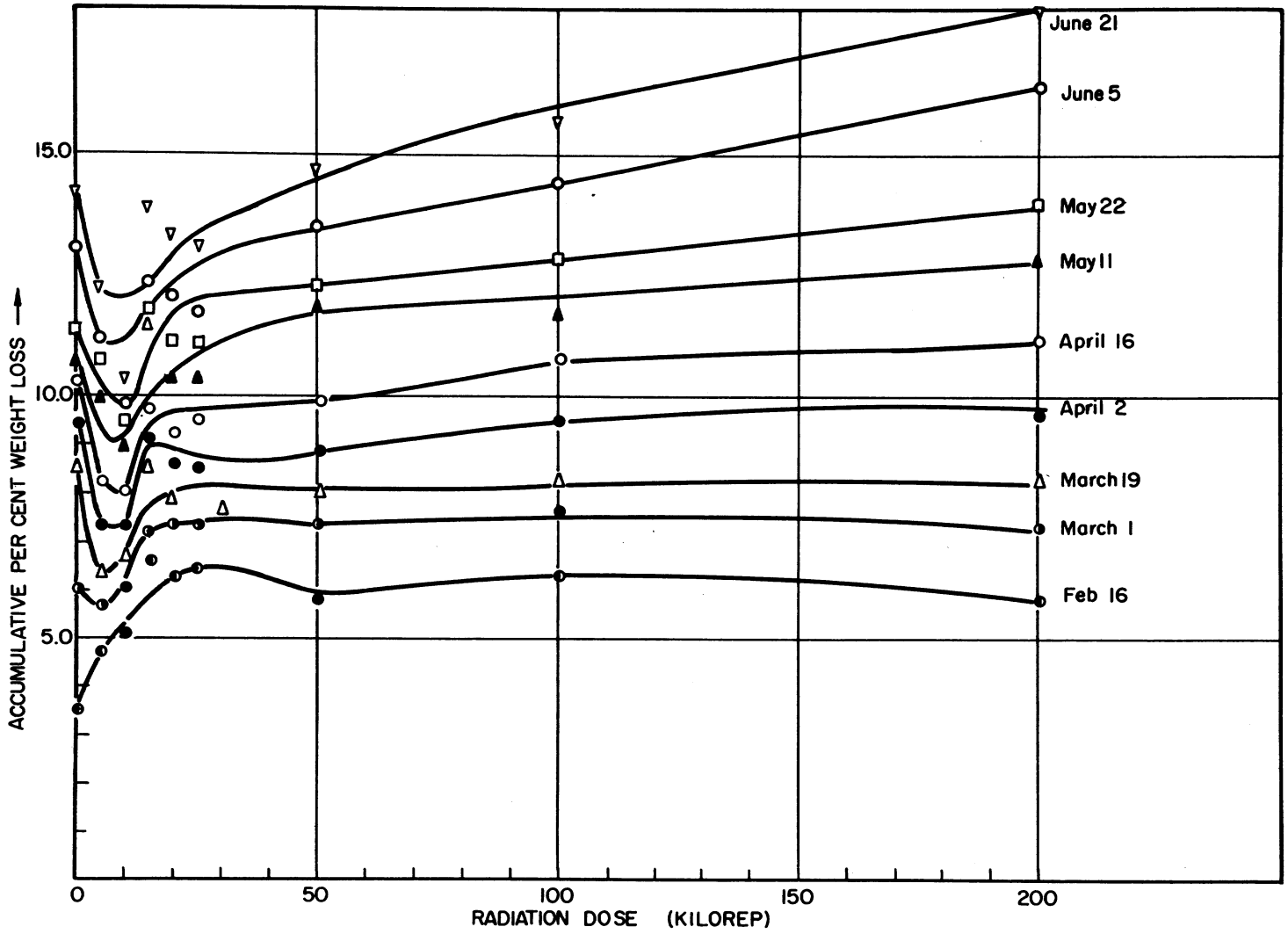

Fig. 2. Accumulative percentage weight loss vs radiation dose for Russet Rural variety potatoes stored since December 7, at 45°F (rotten potatoes included).

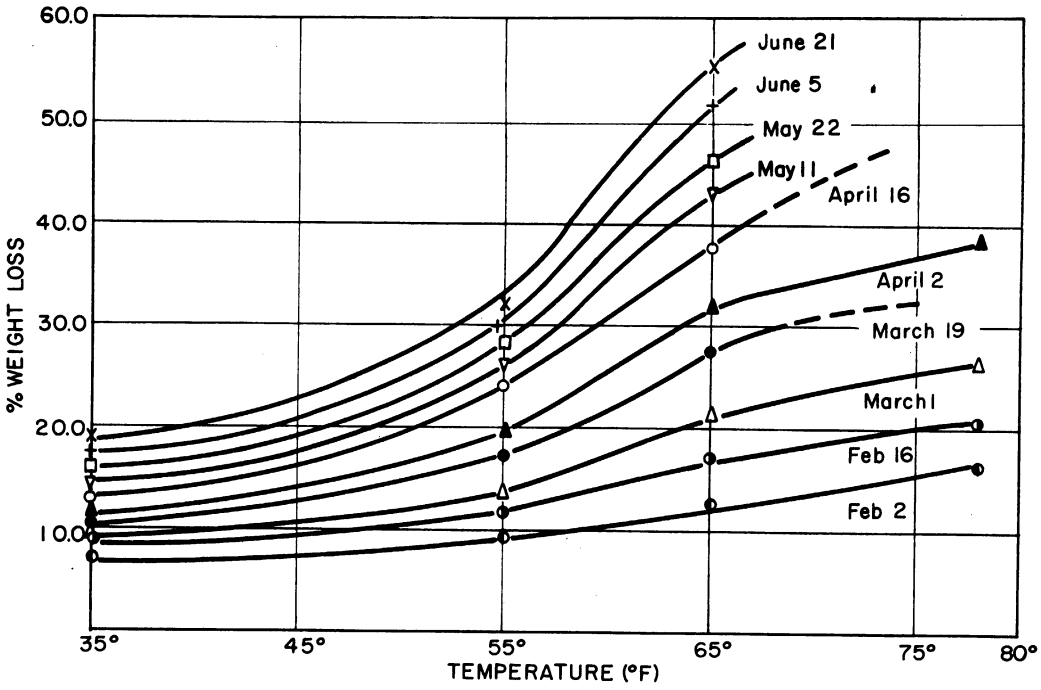

Fig. 3. Accumulative percentage weight loss vs temperature °F for control Sebago potatoes.

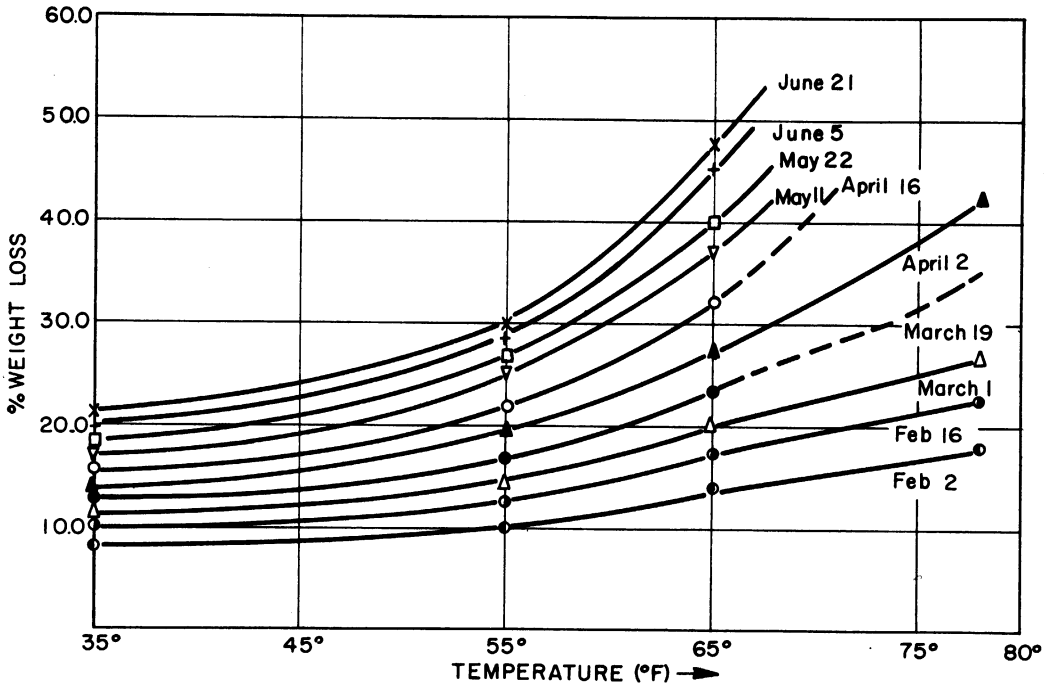

Fig. 4. Accumulative percentage weight loss vs temperature °F for 15-kilorep irradiated Sebago potatoes.

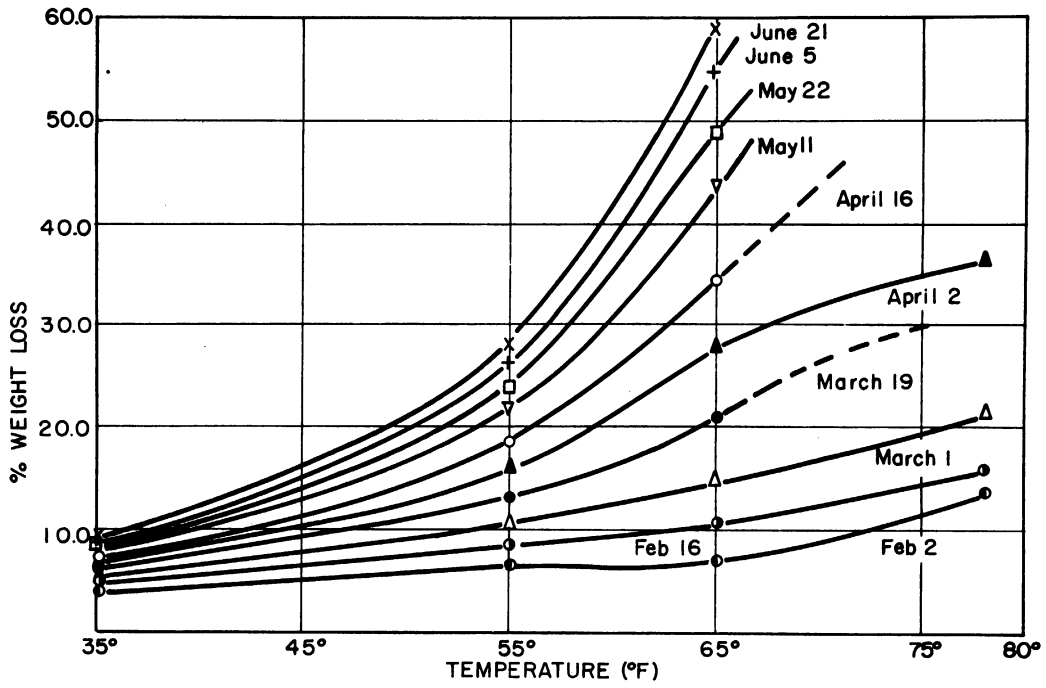

Fig. 5. Accumulative percentage weight loss since December 7 vs temperature °F for control Russet Rural potatoes.

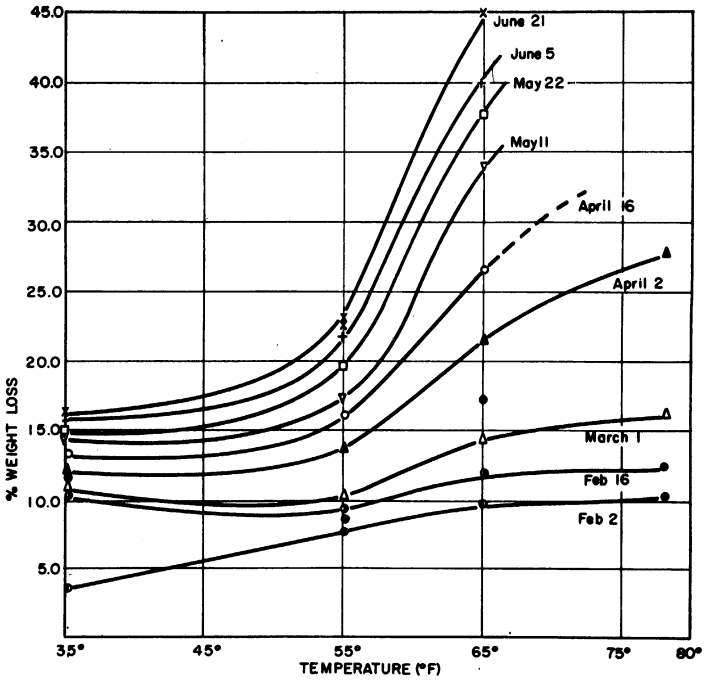

Fig. 6. Accumulative percentage weight loss since December 7 vs temperature °F for 15-kilorep irradiated Russet Rural potatoes.

after storage at 65°F. The differences observed at higher temperatures increase with time.

Figure 7 shows the percentage weight loss, from Tables I and II, plotted against radiation dose after 196 days of storage at 45°F. Comparing the Sebagos with the Russets, under these special conditions, suggests that Russets are better potatoes for storage and less subject to weight loss subsequent to irradiation.

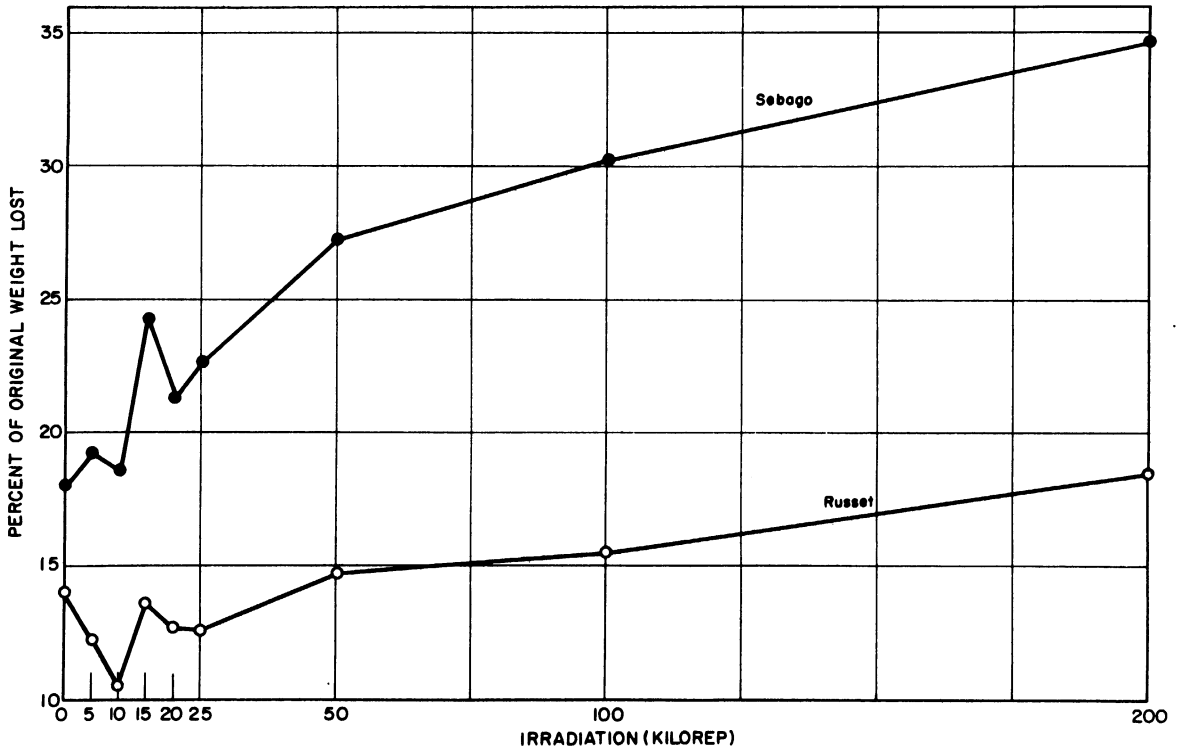

Fig. 7. Percent of original weight lost as a function of radiation dosage (after storage for 196 days at 45°F; rotten potatoes included).

Tables IV and V and Figs. 8 and 9 show the weight of usable potatoes remaining as a function of time after the rotting potatoes have been removed. Sebagos treated with doses of radiation less than 20 kilorep retained more than 60% of their original weight 196 days after irradiation. In the case of Russets, retention over the same period is nearly 80%. In both instances the decrease from 102 days to 196 days is slow, as shown by the gentle slope of the curve. In the case of the high doses of radiation, the slope of the curves is steep, due to the removal of rotting potatoes.

All the Sebagos treated with 200,000 rep were lost in the first 155 days. This dose resulted in the loss of most of the Russets, but after 196 days 20% were still sound.

TABLE IV. PERCENTAGE OF ORIGINAL WEIGHT REMAINING AFTER VARIOUS STORAGE TIMES FOR RUSSET RURAL POTATOES
(Rotten potatoes included)

Temp	Dose (kilorep)	Time Elapsed Since Irradiation (in days)						
		102	116	130	155	166	180	196
35°	0	94.2%	92.5%	91.7%	89.6%	89.1%	88.5%	87.6%
	15	86.7%	86.1%	84.4%	83.7%	83.2%	83.2%	80.3%
45°	0	91.0%	89.7%	88.8%	87.7%	87.1%	86.5%	84.0%
	5	91.8%	90.7%	89.9%	89.2%	88.5%	87.9%	87.2%
	10	91.5%	90.9%	90.2%	89.5%	88.9%	88.3%	87.6%
	15	90.9%	90.3%	89.4%	87.2%	86.5%	85.9%	82.5%
	20	85.0%	84.5%	83.8%	82.5%	82.5%	81.9%	80.1%
	25	91.4%	88.6%	87.7%	85.8%	85.2%	84.9%	83.9%
	50	80.9%	79.9%	79.4%	76.1%	76.1%	75.5%	74.4%
	100	86.8%	84.1%	75.9%	69.5%	68.9%	68.6%	59.0%
	200	73.2%	70.0%	54.1%	35.0%	31.8%	31.8%	19.7%
55°	0	86.2%	83.4%	81.5%	76.3%	74.7%	72.5%	70.4%
	15	87.9%	86.5%	78.5%	70.7%	70.7%	76.5%	68.4%
65°	0	70.4%	64.9%	55.6%	41.6%	38.4%	35.8%	27.5%
	15	68.2%	64.9%	54.1%	38.8%	37.6%	36.9%	32.2%

TABLE V. PERCENTAGE OF ORIGINAL WEIGHT REMAINING AFTER VARIOUS STORAGE TIMES FOR SEBAGO POTATOES
(Rotten potatoes included)

Temp	Dose (kilorep)	Time Elapsed Since Irradiation (in days)						
		102	116	130	155	166	180	196
35°	0	84.0%	82.8%	81.5%	79.6%	79.0%	77.8%	74.1%
	15	78.4%	75.0%	76.3%	74.1%	74.0%	72.5%	52.5%
45°	0	87.7%	84.5%	79.4%	76.9%	75.9%	75.2%	71.6%
	5	84.6%	83.4%	82.1%	80.5%	79.5%	79.4%	74.2%
	10	81.9%	80.2%	76.9%	71.9%	73.9%	73.3%	72.4%
	15	77.4%	74.8%	73.3%	71.1%	70.1%	69.1%	56.8%
	20	76.6%	75.6%	74.4%	69.0%	68.4%	68.1%	66.8%
	25	72.8%	64.8%	64.1%	61.7%	60.9%	60.4%	54.4%
	50	64.1%	61.7%	56.3%	52.9%	52.8%	52.2%	43.4%
	100	63.8%	59.8%	50.4%	35.4%	34.7%	34.4%	22.9%
	200	28.8%	26.8%	13.1%	0.0%	0.0%	0.0%	0.0%
55°	0	82.8%	79.1%	74.7%	70.8%	69.7%	68.2%	66.4%
	15	80.0%	76.4%	73.6%	64.3%	63.7%	63.1%	60.6%
65°	0	70.7%	65.9%	60.6%	43.8%	41.3%	38.8%	18.8%
	15	64.0%	57.2%	50.6%	38.9%	38.2%	37.2%	20.8%

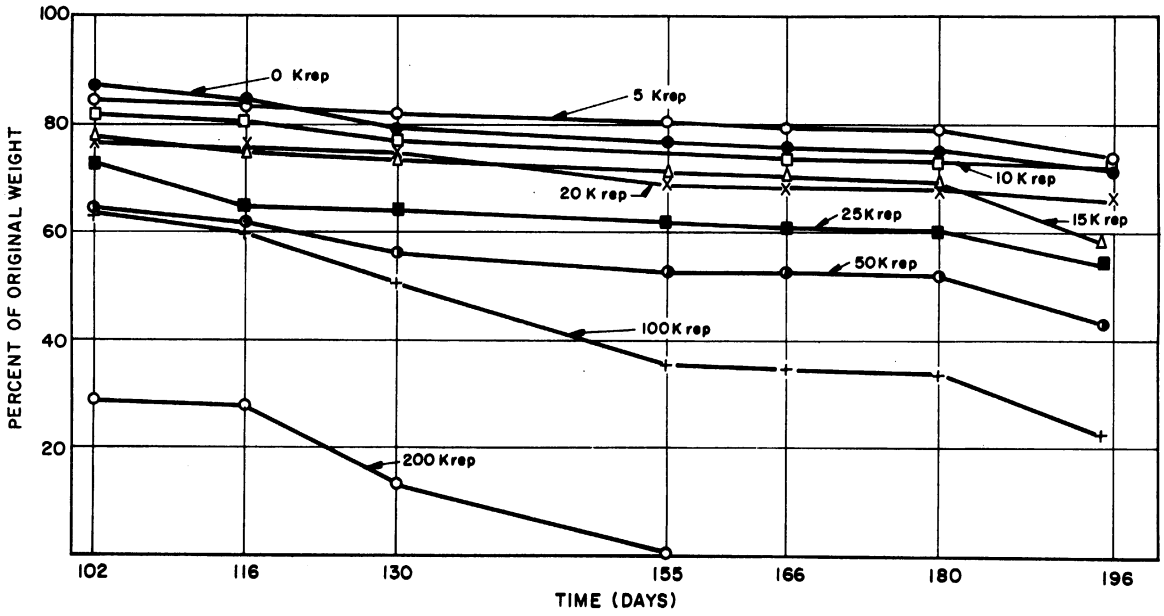

Fig. 8. Percent of original weight of Sebago potatoes remaining as a function of storage time at 45°F (rotten potatoes removed).

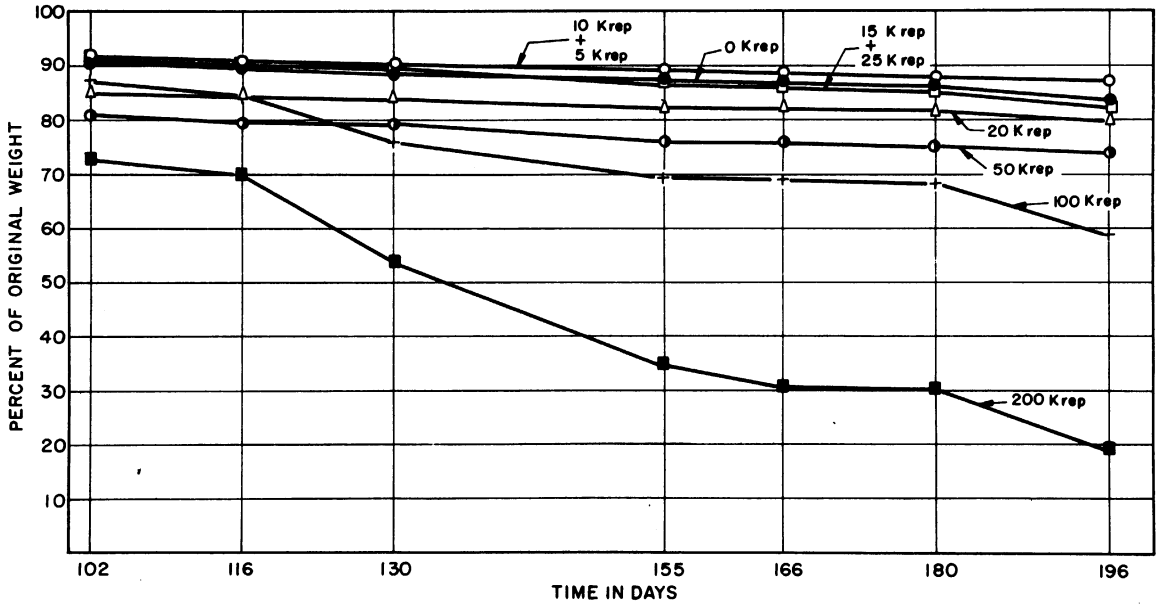

Fig. 9. Percent of original weight of Russet Rural potatoes remaining as a function of storage time at 45°F (rotten potatoes removed). Note: The curve for 10 kilorep is almost identical to the one shown for 5 kilorep.

Figure 10, which is a plot of weight loss (with the rotten potatoes removed) against radiation dose, shows that a dose of 5 or 10 kilorep decreases the weight lost by Sebago potatoes. This was not shown in earlier observations including the weights of the rotten potatoes (see Fig. 1). The curve of Russet weights shows that treatment of these potatoes also with 5 or 10 kilorep will reduce weight loss. The same conclusion was indicated in Fig. 2.

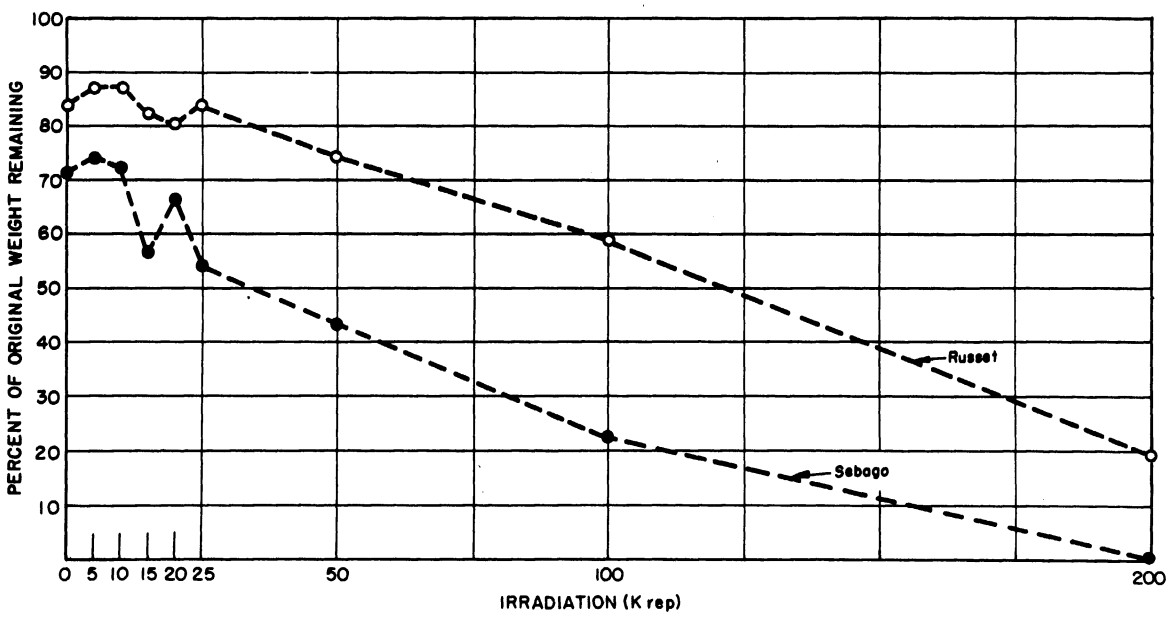

Fig. 10. Percent of original weight of potatoes remaining as a function of radiation dosage (after 196 days at 45°F; rotten potatoes removed).

Since the above curves are affected to a large extent by the removal of rotten potatoes, the percentages of potatoes lost by rotting have been plotted in Figs. 11 and 12 from Tables VI and VII. Figures 11 and 12 with Figs. 8 and 9 compare percent rotten potatoes removed to percent weight loss.

Figures 13 and 14 show the weight losses for Russet Rurals. In no case did the irradiated potatoes rot more slowly than the controls, although the irradiated potatoes stored at 65°F lost less water than the controls, i.e., irradiated potatoes surviving 187 days of storage at 65°F were usable, while the surviving controls were not. (The 65°F room was maintained at an extremely low humidity.)

Figures 15 and 16 show the same data for Sebago potatoes. The results are much the same except that the irradiated Sebagos were preserved longer at 65°F than the controls. This is probably explainable by the dehydration phenomenon noted above.

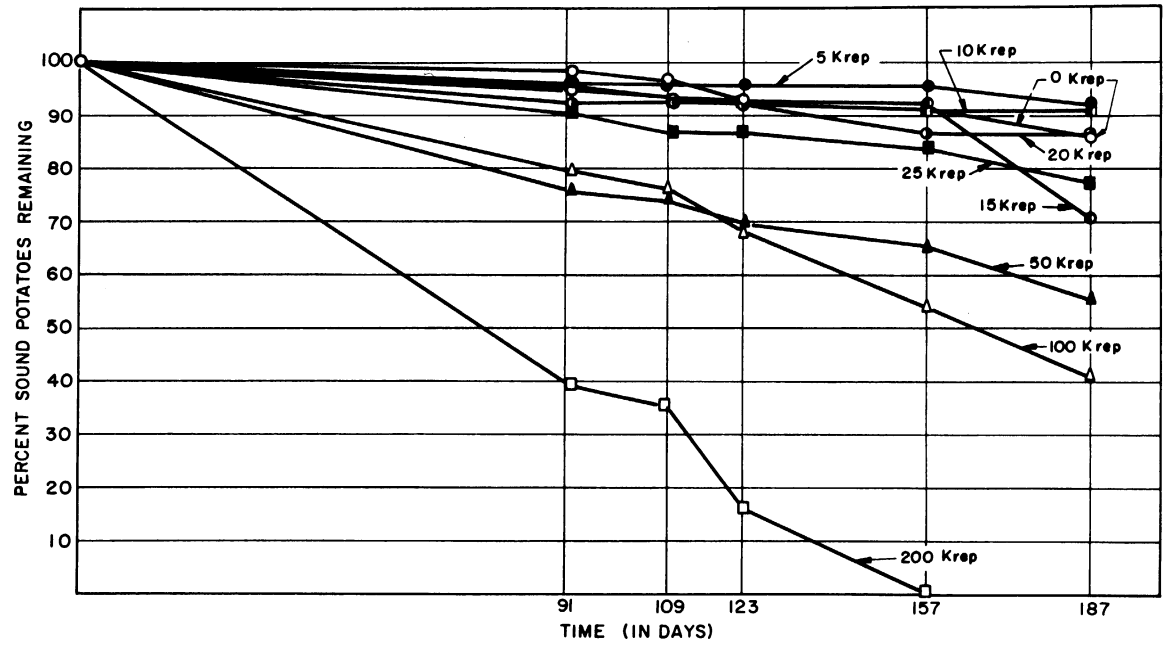

Fig. 11. Percent of original number of Sebago potatoes remaining free of rot vs storage time for various radiation dosages (stored at 45°F).

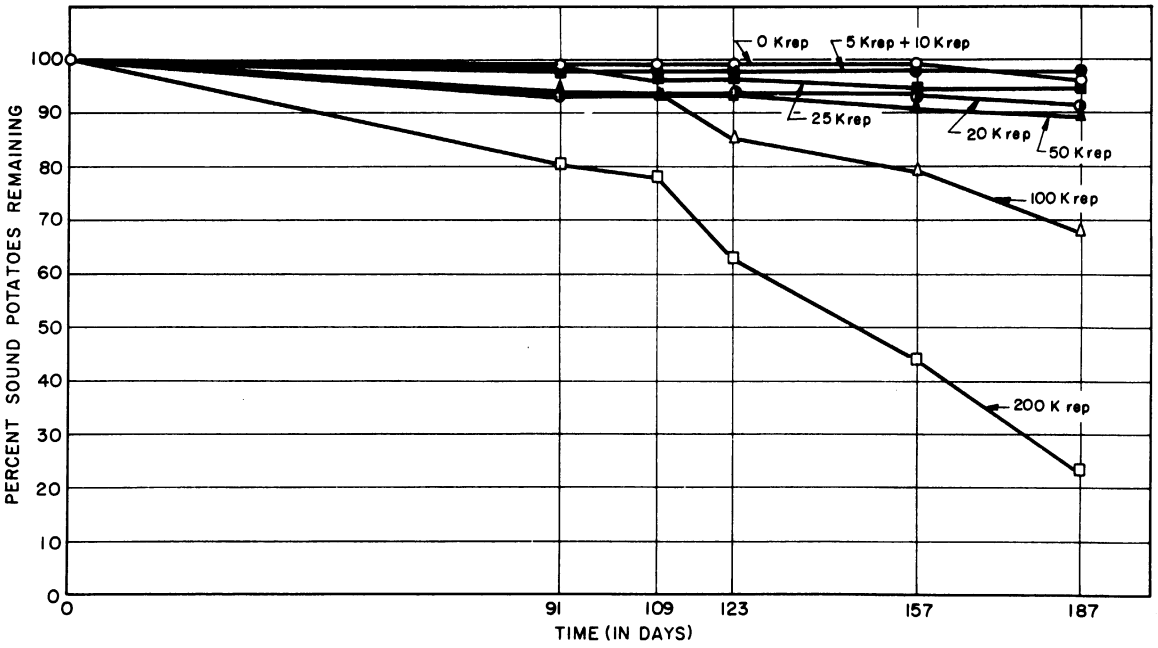

Fig. 12. Percent of original number of Russet Rural potatoes remaining free of rot vs storage time for various radiation dosages (stored at 45°F).

TABLE VI. NUMBERS AND PERCENTAGES OF SEBAGO TUBERS REMAINING FREE OF ROT AFTER VARIOUS STORAGE TIMES

Temp	Treatment \ Time	December 7	March 8	March 26	April 9	May 11	June 12
35°	control	62 (100%)	58 (93.6%)	58 (93.6%)	58 (93.6%)	57 (91.9%)	55 (88.7%)
	15,000	69 (100%)	59 (85.5%)	59 (85.5%)	59 (85.5%)	58 (84.1%)	47 (68.1%)
45°	control	56 (100%)	54 (98.2%)	53 (96.4%)	51 (92.9%)	50 (91.1%)	48 (85.7%)
	5,000	74 (100%)	71 (95.9%)	71 (95.9%)	71 (95.9%)	71 (95.9%)	68 (91.9%)
	10,000	64 (100%)	61 (95.3%)	60 (93.6%)	59 (92.2%)	58 (90.6%)	58 (90.6%)
	15,000	62 (100%)	59 (95.2%)	58 (93.5%)	58 (93.5%)	57 (91.9%)	50 (80.6%)
	20,000	52 (100%)	48 (92.3%)	48 (92.3%)	48 (92.3%)	45 (86.5%)	45 (86.5%)
	25,000	61 (100%)	55 (90.2%)	53 (86.9%)	53 (86.9%)	51 (83.6%)	47 (77.1%)
	50,000	58 (100%)	44 (75.9%)	43 (74.1%)	40 (69.0%)	38 (65.5%)	32 (55.2%)
	100,000	63 (100%)	50 (79.4%)	48 (76.2%)	43 (68.3%)	34 (54.0%)	26 (41.3%)
	200,000	51 (100%)	20 (39.2%)	18 (35.3%)	8 (15.7%)	0 (0.0%)	0 (0.0%)
55°	control	53 (100%)	53 (100%)	52 (98.1%)	50 (94.3%)	50 (94.3%)	50 (94.3%)
	15,000	60 (100%)	58 (96.7%)	57 (95.0%)	56 (93.3%)	53 (88.3%)	51 (85.0%)
65°	control	45 (100%)	43 (95.6%)	43 (95.6%)	43 (95.6%)	33 (73.3%)	16 (33.3%)
	15,000	70 (100%)	63 (90.0%)	60 (85.7%)	55 (78.6%)	45 (64.3%)	30 (42.8%)
Room	control	67 (100%)	58 (86.6%)		49 (73.1%)		
	15,000	57 (100%)	29 (50.9%)		13 (22.8%)		

TABLE VII. NUMBERS AND PERCENTAGES OF RUSSET RURAL TUBERS REMAINING FREE OF ROT AFTER VARIOUS STORAGE TIMES

Temp	Treatment \ Time	December 7	March 8	March 26	April 9	May 11	June 12
35°	control	95 (100%)	95 (100%)	94 (98.9%)	93 (97.9%)	93 (97.9%)	93 (97.9%)
	15,000	89 (100%)	88 (98.9%)	88 (98.9%)	88 (98.9%)	87 (97.8%)	86 (96.6%)
45°	control	79 (100%)	78 (98.7%)	78 (98.7%)	78 (98.7%)	78 (98.7%)	76 (96.2%)
	5,000	93 (100%)	91 (97.8%)	91 (97.8%)	91 (97.8%)	91 (97.8%)	91 (97.8%)
	10,000	82 (100%)	81 (98.8%)	81 (98.8%)	81 (98.8%)	81 (98.8%)	81 (98.8%)
	15,000	69 (100%)	68 (98.6%)	68 (98.6%)	67 (97.1%)	66 (95.7%)	64 (92.8%)
	20,000	60 (100%)	56 (93.3%)	56 (93.3%)	56 (93.3%)	56 (93.3%)	55 (91.7%)
	25,000	58 (100%)	57 (98.3%)	56 (96.6%)	56 (96.6%)	55 (94.8%)	55 (94.8%)
	50,000	86 (100%)	80 (93.0%)	80 (93.0%)	80 (93.0%)	78 (90.7%)	77 (89.5%)
	100,000	87 (100%)	82 (94.3%)	81 (93.1%)	74 (85.1%)	69 (79.3%)	59 (67.8%)
	200,000	86 (100%)	69 (80.2%)	67 (77.9%)	54 (62.8%)	38 (44.2%)	20 (23.3%)
55°	control	67 (100%)	66 (98.5%)	66 (98.5%)	66 (98.5%)	65 (97.0%)	64 (95.5%)
	15,000	63 (100%)	63 (100%)	63 (100%)	58 (92.1%)	56 (88.9%)	56 (88.9%)
65°	control	105 (100%)	96 (91.4%)	95 (90.5%)	90 (85.7%)	75 (71.4%)	*
	15,000	85 (100%)	69 (81.2%)	68 (80.0%)	61 (71.8%)	48 (56.5%)	36 (42.4%)
Room	control	62 (100%)	41 (66.1%)		31 (50.0%)		
	15,000	83 (100%)	53 (63.9%)		30 (36.1%)		

*Potatoes not rotted but in such poor shape as to be unusuable, i.e., due to water loss and consumption of carbohydrate in respiration.

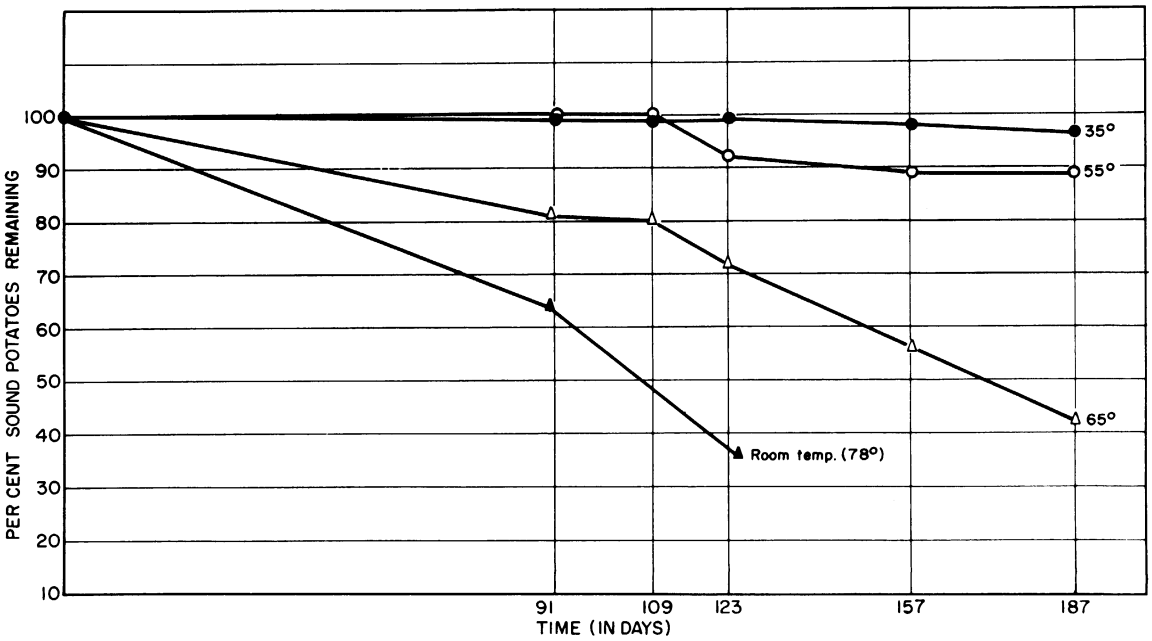

Fig. 13. Percent of original number of Russet Rural potatoes, irradiated with 15 kilorep, remaining free of rot vs storage time for various storage temperatures.

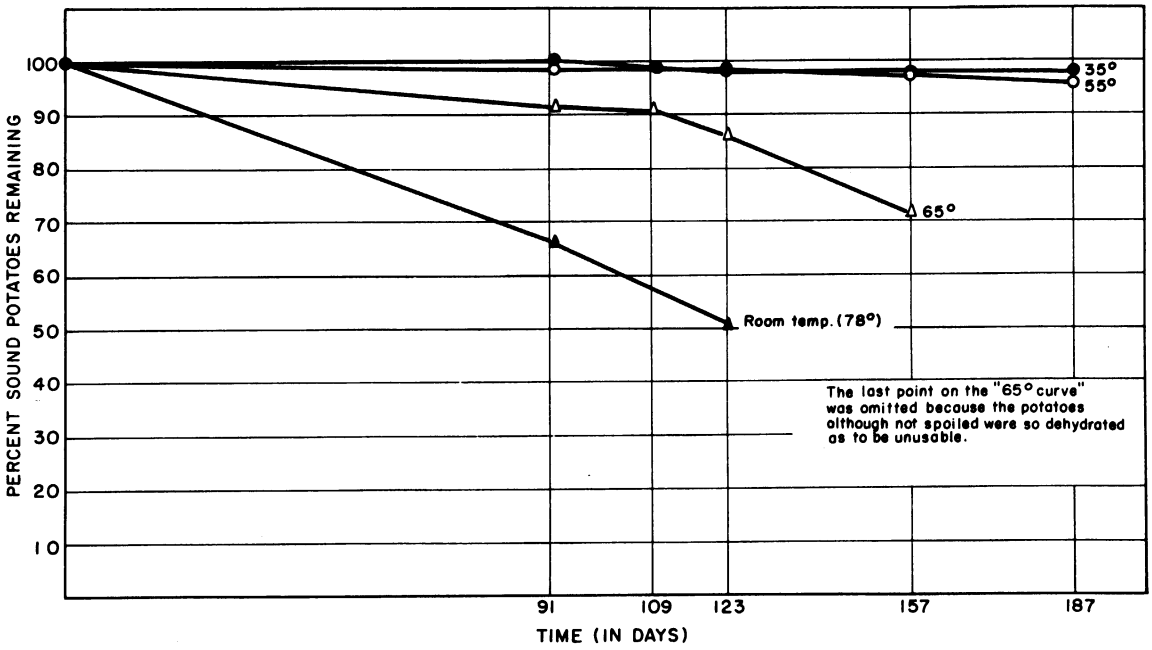

Fig. 14. Percent of original number of control Russet Rural potatoes remaining free of rot vs storage time for various storage temperatures.

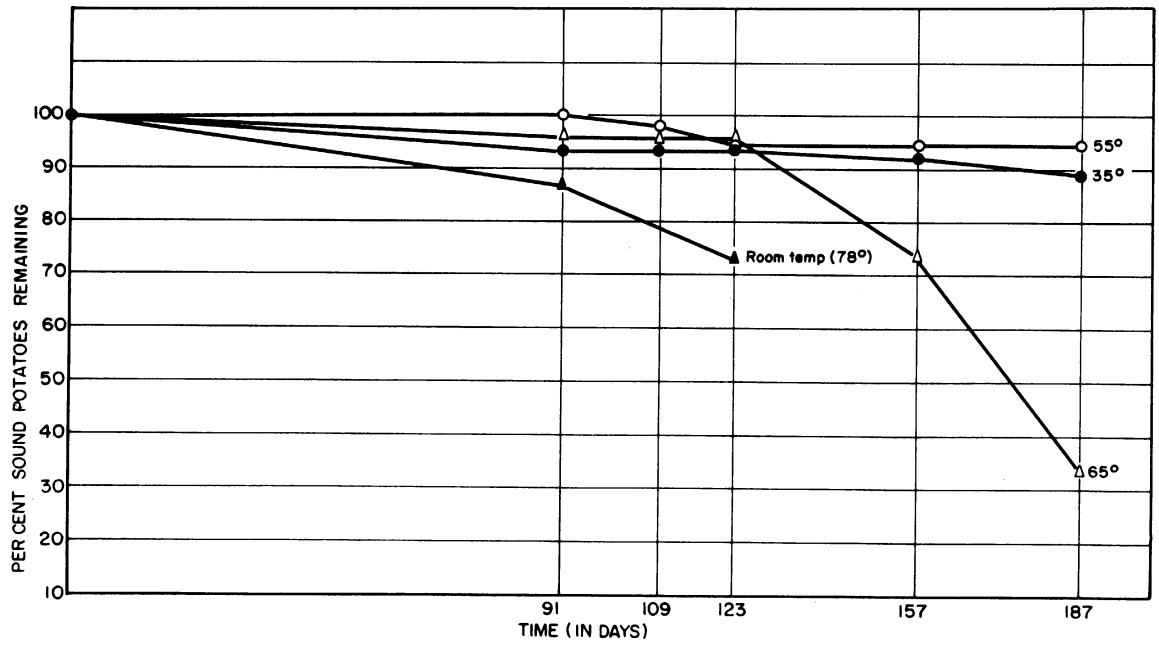

Fig. 15. Percent of original number of control Sebago potatoes remaining free of rot vs storage time for various storage temperatures.

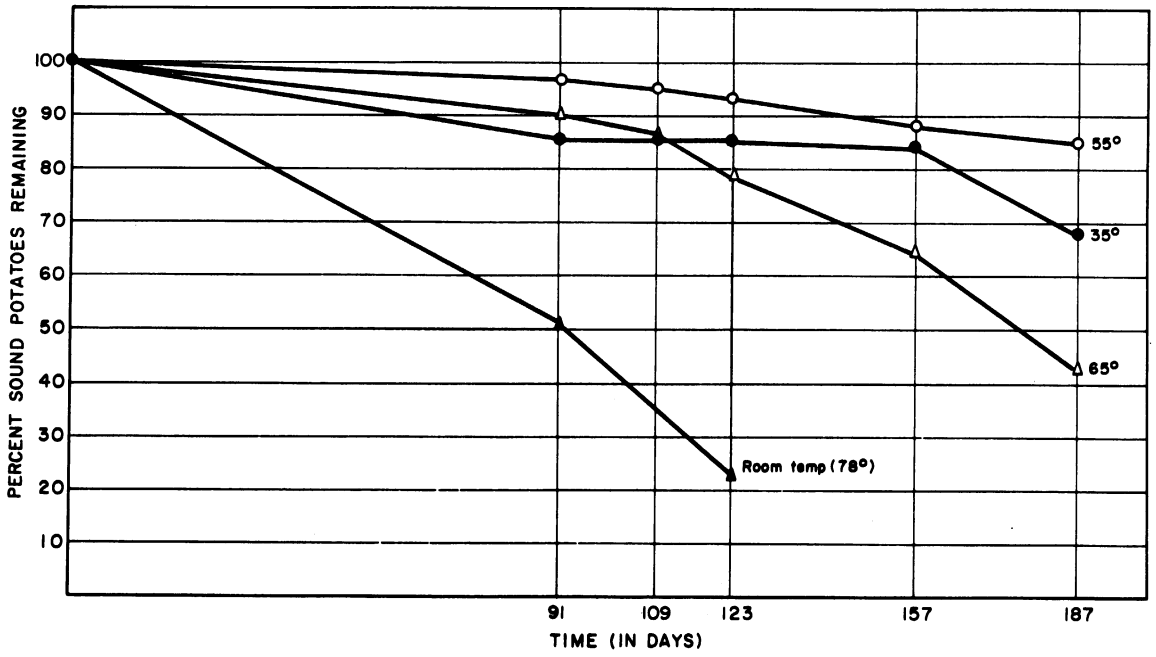

Fig. 16. Percent of original number of Sebago potatoes, irradiated with 15 kilorep, remaining free of rot vs storage time for various storage temperatures.

It would seem, therefore, that a low dose of radiation, perhaps 5 to 10 kilorep, may be optimum in storing potatoes. Dosages of this magnitude stop sprouting and do not cause any increase in weight loss relative to the controls.

Doses of 15 kilorep or more seem inadvisable because of the increase in rotting and general weight loss.

III. EFFECTS OF IRRADIATING PORTIONS OF TUBERS

To seek additional information, potatoes were irradiated with 5 and 10 kilorep as follows: Potatoes which were already sprouted were irradiated with the sprouts shielded. This treatment had no effect on sprout growth, indicating that irradiation does not affect the availability and transport of nutrients in the potato.

Other potatoes already sprouted were irradiated with the tuber shielded and only the sprout receiving radiation. The result was an immediate cessation of growth of the irradiated sprout, with a concurrent commencement of growth in other eyes on the potato. The indication is that the action of radiation on a sprout produces nothing which stops growth in other parts of the organism. Also radiation apparently halts the production of growth hormone (probably IAA) in the tip of the irradiated sprout, which until this time has maintained apical dominance over the other eyes of the tuber inhibiting them from sprouting.

Unsprouted tubers were irradiated at the bud end and then placed in a warm, dark place. The eyes of the potato, other than the bud eyes, sprouted. Usually only the bud eyes sprout. This indicates again that the tiny sprouts were stopped in some way, and once again no sprout inhibiting substance was produced that could move through the tuber to the other eyes and stop their growth.

Probably irradiation disturbs the dividing mechanism or the metabolic systems of the sprout cells. It probably does not affect the metabolic process of the cells of the tubers themselves, which make energy source materials available to the sprouts.

IV. EFFECT OF SEASON OF IRRADIATION UPON STORAGE PROPERTIES

Variations in the storage properties of irradiated potatoes between different experiments, primarily observable in weight-loss data, seem to indicate a possible effect due to the season at which irradiation occurs. Figure 17, taken from Fig. 3 of Progress Report No. 6, indicates these variations. The Sebagos and Russets were irradiated in the early winter, the Idaho seed potatoes in the previous spring.

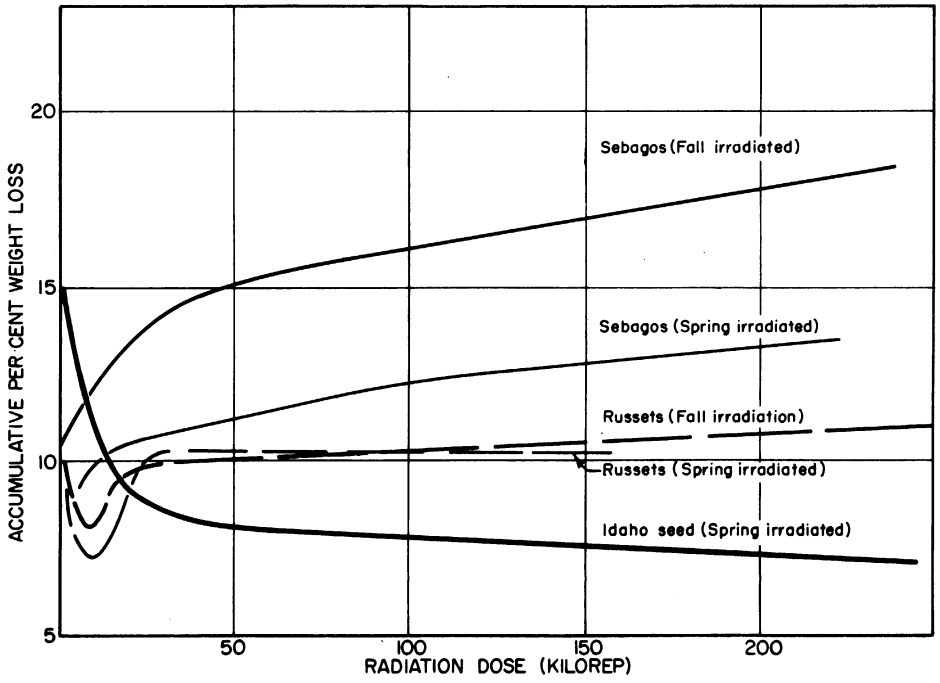

Fig. 17. Comparison of typical data for three varieties of potatoes (percentage weight loss vs radiation dose).

Russet Rural and Sebago potatoes from the same batch used for the experiment illustrated in Fig. 17 were irradiated this spring. These were then used as the basis of a short experiment designed to indicate whether season of irradiation or variety of potato is the important parameter in these differences of storage properties.

The weight-loss data from this short spring irradiation experiment are superimposed on Fig. 17 and seem to indicate that the season of irradiation is not an important contributory parameter in the form of the weight-loss vs dose plot. This would seem to lend strength to the hypoth-

esis, proposed in Progress Report No. 6, of competing radiation-induced and radiation-inhibited processes, whose balance may be shifted between varieties by differences in the physical or chemical nature of the variety under study. Of course, this single, short-term experiment does not establish these hypotheses. Carefully controlled experiments with other parameters held constant, using many different varieties of potatoes, could reveal much about the existence or the nature of these hypothesized interactions.

After the short-term experiment had been in progress for two months, and the corroborating data just discussed had been obtained, the experiment was discontinued. The high rate of spoilage observed in both varieties and the probability that the altered metabolism of the rotting potatoes would tend to invalidate hypotheses based on weight-loss data dictated the termination of the experiment.

V. EFFECT OF RADIATION DOSE UPON ROTTING QUALITY

An appreciable loss by rotting of the Sebagos which had been subjected to 100,000 and 200,000 rep compared to the lower levels of treatment seemed to suggest a possible increase in rotting with dose. The potatoes remaining free of rot, as determined by Mr. Moises Yudelovitch, a trained agronomist, were utilized then for a second short experiment, designed to observe possible variations in rotting rate with dose.

Periodic checks of each potato for any sign of rot gave further indication of dependence of rotting rate on dose. The resulting data are plotted in Figs. 18 and 19.

In both varieties, a marked increase in rotting rate at the higher doses indicates an effect of radiation on the potato, either enzymatic or mechanical, which encourages the growth of rotting organisms. The physiological effect is markedly different between the two species. Rot occurred much more frequently among Sebagos and, when it did occur, usually produced very soft, wet spoilage sites. The predominant rot observed on the Russet Rurals, on the other hand, produced dry, hard spoilage sites.

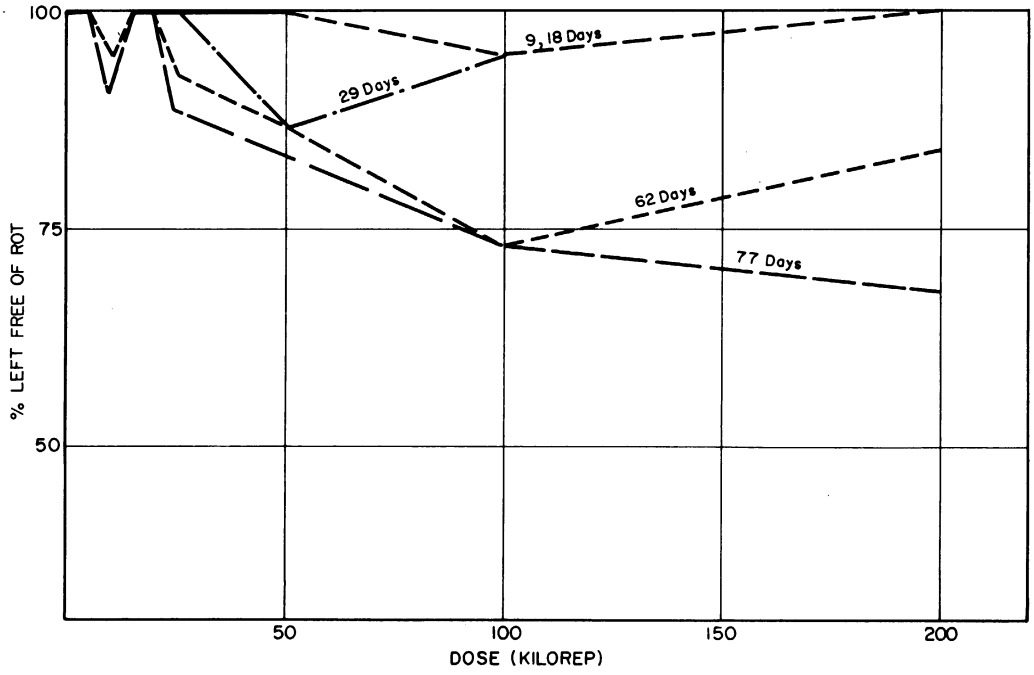

Fig. 18. Percent of Russet Rurals remaining free of rot after various periods of storage at 45°F.

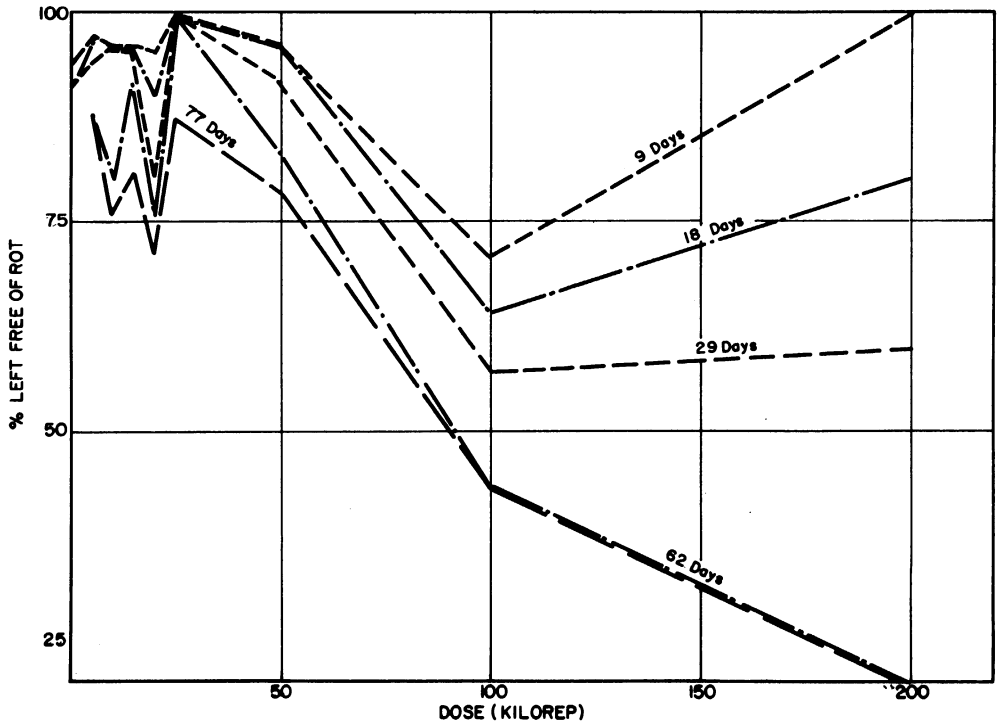

Fig. 19. Percent of Sebagos remaining free of rot after various periods of storage at 45°F.