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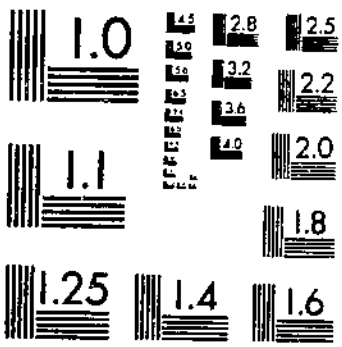
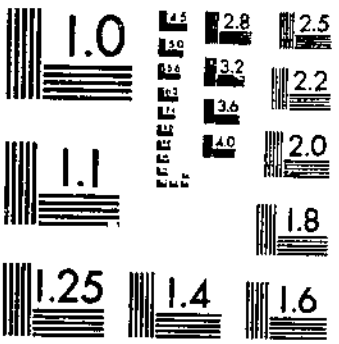


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 415 July 1934

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

SHORTENING THE REST PERIOD OF THE POTATO

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CONTENTS

INTRODUCTION

Bernard's (*2*) [1] discovery in 1878 that plants, like animals, were rendered insensible when subjected to ether fumes, while serving to establish a close physiological relationship between members of the animal and vegetable kingdom, did not indicate the after-effect upon plants that were in a state of rest at the time of the anaesthetization. It was not until 12 years later (1890) that Johannsen (*6*), of the Royal Danish School of Copenhagen, Denmark, conceived the idea that ether or chloroform might be successfully used to shorten the rest period of plants. The presentation in 1893 of a paper by Johannsen (*7*) before the Royal Academy of Science of Copenhagen, giving the results of experimental studies on the effect of anaesthetizing willows and bulbous plants, at once aroused keen interest in the subject. This stimulation of interest in the possibilities involved in the use of anaesthetics in plant forcing became general, and it was not long before some European nursery firms were advertising anaesthetized dormant hard-wooded flowering plants for sale.

Later studies have shown that many chemicals other than those producing anaesthesia can be employed with satisfactory results in shortening the rest period of many classes of plants. It has also been found that the subjection of certain plants in a state of rest to relatively low or high temperature or to immersion in warm water shortens the rest period.

[1] Italic numbers in parentheses refer to Literature Cited, p. 30.

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REST OR DORMANT PERIOD

In much of the literature dealing with methods for hastening the germination of potato tubers the terms "rest period" and "dormancy period" are used synonymously. Because in a certain sense these two terms are not identical in meaning it seems desirable to attempt the formulation of a clearer definition of their meaning. The rest period as applied to outdoor plants, in northern latitudes especially, is that interval between the cessation of active growth and the time when it is again resumed, assuming, of course, that temperature is not the inhibiting factor. Dormancy, on the other hand, is an all-inclusive term, embracing not only the normal rest period of the plan but also that interval of time beyond the true rest period, in which growth is inactive as a result of low temperature.

Most deciduous and herbaceous outdoor plants in northern latitudes have certain well-defined periods of rest, the intensity of which is not uniformly alike. Johannsen (*6*) suggestively divided this resting stage into three periods which he called "before rest", "middle rest", and "after rest." In the first and third rest periods the plant is more easily incited into growth than in the middle or deep-rest period, during which it responds less readily to external stimuli, such as heat, moisture, and light. In the case of the potato the deep-rest period begins about the time of tuber maturity and continues from 70 to 90 days. Appleman (*1*) in his study of the rest period of potato tubers found that under natural planting conditions the McCormick potato would begin to germinate about 90 days after harvesting.

After potato tubers emerge from the middle or deep-rest period further inactivity is entirely dependent on the temperature at which they are held. This dormancy or inactivity is entirely apart from the rest period and should not be confused with it. Hence, the true effectiveness of any agency employed to hasten germination can only be properly evaluated when the treatment is made during the first portion of the deep-rest period.

PREVIOUS EXPERIMENTAL STUDIES

The earliest experimental effort to abridge the normal rest period of the potato in the United States that has come to the writers' attention was reported by McCallum (*9*) in 1909. This report was based on studies conducted during the crop seasons of 1907 and 1908. According to that author these studies were the outcome of an inquiry relating to tuberization in potatoes, which indicated the necessity of a more adequate knowledge of the many factors involved in tuber formation. One of these factors was the shortening of time for the crop to mature, in addition to the time saved by green sprouting the seed before planting. It was thought that germination might be hastened by treating the cut seed or whole tubers with some stimulative agent. Among the most effective of those employed by McCallum (*9*) were ethyl bromide, carbon tetrachloride, ammonia, gasoline, ethylene chloride, bromine, etc. The best success followed treatment with ethyl bromide. Manganese chloride and ethyl ether were found to induce a marked acceleration in tuber formation.

Appleman (*1*) found that the rest period could be shortened and sprouting induced by the removal of the skin, especially around the eyes.

On the assumption that oxygen might be a limiting factor, tubers were wrapped in cotton previously saturated with hydrogen peroxide and then stored in moist chambers, which in turn were buried in moist sawdust under a greenhouse bench.

Tubers wrapped in cotton saturated with a 3-percent solution of hydrogen peroxide showed 100-percent germination in 28 days, as compared with 43 days in the case of those wrapped in cotton soaked in a 1-percent solution.

The effect of anaesthetics was also tried by Appleman (*1*) on blocks of tissue 1 centimeter square, each containing a single eye. Ether gas proved ineffective, but marked results were obtained from ethyl bromide. The periods of treatment tested were 2, 4, 5, 10, and 20 minutes, while whole tubers were treated for 15 and 30 minutes. The quickest response was obtained from the 5-minute treatment.

In some experiments conducted by Rosa (*11*) in 1923 it was found that the rest period of cut seed potatoes could be materially abridged by soaking the seed in solutions of $NaNO_3$, $Ca(NO_3)_2$, $Mg(NO_3)_2$, $Mn(NO_3)_2$, $KMnO_4$, $(NH_4)_2SO_4$. The conclusions drawn were that the sprouting of dormant tubers can be hastened and the percentage of germination within a limited period after treatment can be increased by dipping the cut seed pieces in a 0.5 molecular solution of sodium nitrate ($NaNO_3$). Other oxidizing substances to which the cell is permeable and which are not toxic when used in proper concentration had a similar effect.

In a later report Rosa (*12*) presented the results of studies conducted the winter of 1923–24 and the fall of 1924. These studies involved a determination of the relation of temperature to the nitrate of soda treatment of cut seed. Lots of tubers were soaked for 1 hour in a 0.5 molecular nitrate of soda solution at 18°, 24°, 31°, and 40° C. (64°, 74.8°, 87.5°, and 104° F., resp.). It was found that the average time required for germination decreased slightly as the temperature increased to 36° C.[2] (96.8° F.), while severe injury occurred at 40° C. (104° F.). In later field tests it was observed that treatments in a given strength and period were considerably more toxic to the seed piece during hot weather than during cool weather.

Ethylene gas was first tested by Rosa (*13*) in 1923 as an agent for shortening the rest period of potatoes. Three varieties, American Giant (White Rose), Charles Downing (Idaho Rural), and Irish Cobbler were used in the experiment. Cut seed pieces were exposed for 4 weeks to three concentrations of the gas, except in the case of the Irish Cobbler sets which were only exposed to the two higher strengths. The gas concentrations employed were 1: 1,000, 1: 5,000, and 1: 100,000 parts. The chambers were ventilated every day or two during the treatment, and the gas concentration restored after each ventilation period.

It was found that the American Giant responded most readily to the treatment, with the Charles Downing and Irish Cobbler following in the order mentioned. Evidently these varieties have a longer or deeper rest period than the American Giant.

Considerable impetus was given to the study of the most effective means of shortening the rest period of potatoes through the publication of a paper by Denny (*3*), which included a study of the effect of 224 different chemical substances. In these tests ethylene chlorhy-

[2] No mention is made by Rosa of having soaked cut seed in a 36° C. solution.

drin ($ClCH_2CH_2OH$) and the thiocyanates of sodium and potassium stood out most prominently in hastening germination.

The germination of cut seed of Triumph was found to be materially hastened when soaked in solutions of ethylene chlorhydrin varying in concentration from 3 to 10 cc per liter. Freshly harvested Irish Cobblers responded to a 4-cc-per-liter concentration in which the cut sets were soaked for 2 hours.

The volatility of ethylene chlorhydrin also permitted its use as a gas. Three methods of application were used. The first was by placing 0.5 to 1 cc of ethylene chlorhydrin in a shallow pan resting on the cut sets, which were held in an airtight container of 1-liter capacity for a period of from 16 to 24 hours.

The second method consisted in arranging the cut sets in layers about 6 inches deep in tight containers and then covering each layer with burlap saturated with a solution of ethylene chlorhydrin and holding them overnight. The concentration used to saturate the burlap cloth was 100 cc per liter.

The third method consisted in dipping the cut seed in a 3-percent ethylene chlorhydrin solution and holding them in a closed container for 16 to 24 hours.

Fairly satisfactory results were obtained from the first and last methods.

The rest period of cut sets was materially shortened when the tubers were soaked in 3- or 2-percent solutions of either sodium or potassium thiocyanate. Soaking in a 1-percent solution was found to be less effective, and distinct injury resulted from the use of a 4-percent solution.

Treatment of cut sets by soaking 1 hour in a 1-percent solution of thiourea caused the development of multiple sprouts. In a later experiment additional evidence was obtained by Denny (*4*) in regard to the peculiar reaction of potato buds to this treatment. Multiple sprouts from one-eyed seed pieces were observed in the Irish Cobbler, Triumph, Rural New Yorker No. 2, and McCormick varieties.

In studying the relationship of temperature to the effectiveness of chemical treatment of seed potatoes to hasten germination, Denny (*5*) found that when cut seed was held for 16 to 24 hours in a closed jar after dipping in an ethylene-chlorhydrin solution a temperature of 95° F. caused a considerable rotting of the seed, while at 59° the treatment was more or less ineffective. Favorable responses in breaking the rest period were obtained between 68° and 90°. It was also found that when the treatment consisted in soaking the cut seed in a 1- to 2-percent solution of either sodium or potassium thiocyanate the temperature of the solution was of less importance. This observation confirms that of Rosa (*12*), to which reference was made earlier in this publication.

Any review of previous experimental evidence, however brief, would be incomplete without discussing the effect of temperature alone in shortening the rest period.

Among the workers who have used other than chemical means for breaking the rest period, Müller-Thurgau (*10*) may be regarded as one of the earliest. He was able to force potatoes into growth by storing them for a month after harvesting at a temperature of 32° F. In a later paper negative results were reported from a 1-hour bath in water at 35° C. (95° F.).

Loomis (*8*) found that the rest period of potatoes can be broken in 4 weeks by storage during July in the attic of a low-roofed building. Extended studies prove the efficacy of storage temperatures around 86° F. in shortening the rest period of potato tubers.

Tubers weighing 3 and 4 ounces, selected from a given lot of freshly dug potatoes, germinated more readily and made a stronger growth than 1- and 2-ounce tubers from the same lot. The difference was lost as the tubers passed through the rest period.

DEPARTMENT OF AGRICULTURE STUDIES

The studies upon which the present report is based were primarily undertaken with a view to securing additional information in regard to varietal responses to chemical treatments for breaking the rest period. A preliminary study of such varietal responses was begun in the fall and winter of 1928–29 and was continued more extensively and thoroughly during 1929–30 and 1930–31.

The chemical treatments and methods of application were essentially those recommended by F. E. Denny, who collaborated with the Department in the fall of 1927, conducting chemical treatments of newly harvested Maine-grown Triumph seed potatoes for immediate planting at Belle Glade, Fla. The potatoes were harvested and shipped direct to Florida by express, where they were promptly treated and planted. In this experiment Dr. Denny discovered that seed dipped in a solution of ethylene chlorhydrin and kept in a closed container for 24 hours, when the day temperature was 90° F. or above, was distinctly injured.

EXPERIMENTAL TREATMENTS

SEASON OF 1928–29

Preliminary studies during 1928–29 included observations on the behavior or reaction of a number of varieties to the ethylene-chlorhydrin treatment and a more detailed study with the Irish Cobbler and Dakota Red (Jersey Red Skin) varieties of the effect of different strengths and periods of treatment in which sodium thiocyanate (Na SCN) as well as ethylene chlorhydrin was used. The treated seed in all of the earlier experiments was immediately planted in 4-inch pots and germinated in a greenhouse temperature of from 55° to 75° F.

In no instance were the tubers treated as soon after harvesting as is considered desirable to obtain the most striking differences between the date of germination of the treated and untreated seed. This delay was partly unavoidable because the stock used in the experiment was grown in Maine, harvested about September 25, and held until a convenient time to prepare the material for shipment to Washington. The shipment was sent about October 10, which meant arrival at Washington sometime between October 20 and 25. Other duties delayed the treatment until November 12, or approximately 48 days from the time of harvesting.

Notwithstanding these delays, some interesting data were obtained, as shown in table 1. Because of the small sample of each variety it was not possible to use check lots; hence the chief interest of this study is the relative response of the several varieties to the ethylene-chlorhydrin treatment.

TABLE 1.—*Effect of treating cut seed of different varieties of potatoes by dipping in a 4-percent solution of ethylene chlorhydrin and storing in a closed container for 24 hours to hasten germination*

[Sets treated Nov. 12, planted Nov. 13, 1928]

Variety	Sets	Rate of germination in—						
		9 days	11 days	13 days	18 days	21 days	24 days	28 days
	Number	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Noroton Beauty	30				46.7	80.0	100	
Charles Downing	30				76.7	83.3	93.3	93.3
Scotch Rose	30			10.0	53.3		63.3	70.0
Early Manistee	30			50.0	86.7	93.3	93.3	100
White Star	30				10.0	16.7	23.3	30.0
White Ohio	30							3.3
Extra-Early Rockford	30							0
White Rose (White Elephant, etc.)	30				30.0	36.7	66.7	76.7
Early Rose	30			16.7	86.7	93.3	93.3	100
Beauty of Hebron	30			6.7	53.3	70.0	86.7	90.0
Burbank (Low-top)	30			6.7	33.3	46.7	50.0	50.0
Pride of Multnomah	30				13.3	13.3	20.0	20.0
Gold Coin	30				13.3	20.0	23.3	33.3
Russet Rural (Late Petoskey)	30				3.3	3.3	3.3	6.7
Peachblow (Red McClure)	30				10.0	10.0	10.0	10.0
Earliest of All	30				63.3	70.0	80.0	86.7
Dakota Seedling	30				10.0	13.3	13.3	16.7
Adirondack	30				26.7	30.0	36.7	50.0
Queen-of-the-Valley	30					3.3	6.7	6.7
Dakota Red	30							0
Early St. George	29			17.2	75.9	93.1	96.5	100
Prolific (Brown Beauty)	29	6.7	16.7	43.3	93.3	96.7	100.0	
Keeper	29		6.7	10.0	50.0	70.0	80.0	90.0
Charles Downing	20			10.0	30.0	70.0	80.0	95.0
Seedling No. 9	30				33.3	83.3	76.7	83.3
McCulloch	30		30.0	60.0	86.7	96.7		96.7
Cow Horn (light type)	20		5.0	30.0	43.3	80.0	80.0	80.0
Prince Albert	30		13.3	30.0	76.7	90.0	93.3	96.7

Of the 27 varieties, or 28 lots, treated, Prolific (Brown Beauty) showed the quickest response, with nearly 7-percent germination in 9 days. In 11 days after treatment 5 varieties gave germination counts varying from 5 to 30 percent, while after 13 days nearly half of the 28 lots showed varying degrees of response. The most interesting feature of these data is the behavior of the Dakota Red, the White Ohio, and the Extra Early Rockford, the latter being a strain of the Early Ohio. Neither the Extra Early Rockford nor the Dakota Red showed evidence of germination after 28 days, and only 1 of the 30 White Ohio seed pieces sprouted.

The value of any treatment for shortening the rest period of the potato is its effectiveness in securing a satisfactory percentage of germination in a minimum time interval. A study of the data in table 1 shows that 6 of the 27 varieties—Early Manistee, Early Rose, Early St. George, McCulloch, Prolific, and Prince Albert—gave a germination of 90 percent or over in 21 days, while the Charles Downing and Noroton Beauty required 24 days and Beauty of Hebron and Keeper 28 days. In other words, only onethird of the varieties responded with a 90-percent, or better, germination in 28 days.

In order to obtain additional light on the efficacy of different strengths and periods of treatment with ethylene chlorhydrin and sodium thiocyanate, 27 lots of 20 seed pieces each of the Irish Cobbler were treated on November 27, 1928. These treatments varied from 6 to 48 hours.

The data in table 2 indicate the most pronounced results from seed dipped in a 6-percent solution of ethylene chlorhydrin and held in a

closed container from 36 to 48 hours. Seed dipped in a 1-percent solution of sodium thiocyanate and held in tight containers for 24, 36, and 48 hours, also those dipped in a 2-percent solution of the above chemical and held in tight containers for 6, 12, 18, and 24 hours gave nearly as good results as those in the 6-percent ethylene chlorhydrin treatment. Seed gassed for 12 hours with 5 cc of ethylene chlorhydrin per liter of container space showed the highest percentage of germination in 15 days. Considerable foliage injury was noted in plants produced from seed dipped in a 3-percent sodium-thiocyanate solution and then held in closed containers for periods of 6, 12, 18, and 24 hours. This treatment also delayed germination.

TABLE 2.—*Germination results obtained with Irish Cobbler seed pieces treated with chemicals to break the rest period*

[Treated Nov. 27, planted Nov. 30, 1928]

Treatmen	Duration of treatment	Rate of germination in—				
		15 days	17 days	19 days	26 days	31 days
	Hours	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Seed dipped in a 4-percent solution of ethylene chlorhydrin, then put in tight container for periods stated	24	.....	15	50	85	95
	36	.....	10	20	75	80
	48	5	40	75	90	90
Seed dipped in a 6-percent solution of ethylene chlorhydrin, then put in a tight container for periods stated	24	10	80	90	95	95
	36	5	85	90	100	.....
	48	.....	90	85	100	.....
Seed gassed in a tight jar with 1 cc per quart of ethylene chlorhydrin for periods stated	0	.....	5	15	45	60
	12	.....	15	45	60	95
	18	.....	15	55	85	95
	24	.....	40	50	75	80
Seed gassed in a tight jar with 2 cc per quart of ethylene chlorhydrin for periods stated	6	.....	5	25	50	65
	12	.....	30	75	95	95
	18	.....	10	45	85	90
	24	.....	30	60	70	85
Seed gassed in a tight jar with 5 cc of ethylene chlorhydrin for periods stated	6	.....	45	75	90	90
	12	15	55	80	95	100
Seed dipped in a 1-percent solution of sodium thiocyanate, then put in a tight container for periods stated	24	.....	40	80	100	.....
	36	.....	60	80	90	100
	48	.....	30	75	95	100
Seed dipped in a 2-percent solution of sodium thiocyanate, then put in a tight container for periods stated	6	.....	.....	25	85	95
	12	5	35	60	9[illegible]	100
	18	5	55	70	80	.....
	24	5	55	75	95	95
Seed dipped in a 3-percent solution of sodium thiocyanate, then put in a tight container for periods stated	6	.....	.....	25	55	[1] 60
	12	.....	5	15	85	[1] 95
	18	.....	.....	5	70	[1] 85
	24	.....	.....	10	65	[1] 80
Check held in tight container	48	.....	.....	5	35	45
Check, freshly cut seed	.....	.....	.....	20	65	90
Check dipped in water	48	.....	.....	15	45	75

[1] Considerable injury to plants.

The first experiment, which is recorded in table 1, showed that the Dakota Red did not respond to the ethylene-chlorhydrin treatment, at least not during the 28-day observation period. On this account it was thought desirable to conduct further studies with it. Twenty lots of seed of this variety were treated December 18, as indicated in table 3. The concentrations of ethylene chlorhydrin and sodium thiocyanate were similar to those employed in the case of the Irish Cobbler, as were also the periods of exposure. It will be noted from the data in table 3 that very different results were obtained from those recorded in table 1 for the lot treated 36 days earlier. For comparison with the seed pieces treated in a similar manner December 18, the seed pieces treated November 12 were dipped in a 4-percent

ethylene-chlorhydrin solution and subsequently exposed to the gas in a tight container for 24 hours. It was found that the earlier treatment showed no response in 28 days, whereas in the later treatment 100-percent germination was secured in 27 days. It is interesting to note also that the check did not show any germination on this date, and it was not until 6 days later, or 33 days from the planting of the seed, that the freshly cut seed showed a 5-percent germination, while that cut and held 48 hours in a tight container had a 20-percent count.

Apparently there was some retardation due to the 48-hour treatment of seed dipped in a 4-percent solution of ethylene chlorhydrin. In the case of the 6-percent solution it is apparent that the 12-hour exposure was not so effective as the 24-, 36-, or 48-hour treatments. The 36-hour exposure was the most effective. Gassing the seed with 1, 2, or 5 cc of ethylene chlorhydrin per quart jar was much less effective than dipping and gassing combined and resulted in an appreciable percentage of decayed seed.

TABLE 3.—*Germination results obtained with Dakota Red seed pieces treated with chemicals to break the rest period*

[Treated Dec. 18, planted Dec. 20, 1928]

Treatment	Duration of treatment	Rate of germination in—					Decayed seed
		15 days	18 days	21 days	27 days	33 days	
	Hours	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Seed dipped in a 4-percent solution of ethylene chlorhydrin, then put in a tight jar for periods stated	24	30	60	70	100	------	------
	48	------	25	60	95	100	------
Seed dipped in a 6-percent solution of ethylene chlorhydrin, then put in a tight jar for periods stated	12	5	20	35	65	85	------
	24	60	75	90	95	------	------
	36	60	95	100	------	------	------
	48	50	70	80	90	95	------
Seed gassed with 1 cc of ethylene chlorhydrin per quart in a tight jar for periods stated	24	20	25	------	35	45	30
	48	10	30	45	50	------	45
Seed gassed with 2 cc of ethylene chlorhydrin per quart in a tight jar for periods stated	12	5	25	50	60	65	5
	24	15	45	55	60	------	35
	48	------	10	20	35	------	65
Seed gassed with 5 cc ethylene chlorhydrin per quart in a tight jar for periods stated	12	------	25	40	60	70	25
	24	------	15	30	75	80	20
Seed dipped in a 1-percent solution of sodium thiocyanate, then put in a tight jar for periods stated	24	5	60	85	90	100	------
	36	15	80	95	100	------	------
	48	10	65	80	95	100	------
Seed dipped in a 2-percent solution of sodium thiocyanate, then put in a tight jar for periods stated	12	------	00	90	100	------	------
	24	------	35	65	100	------	------
	36	------	10	05	100	------	------
	48	------	40	60	100	------	------
Check seed, cut at same time as the others and held in a tight jar for period stated	48	------	------	------	------	20	------
Check, freshly cut seed	------	------	------	------	------	5	------

Seed dipped in 1- and 2-percent sodium-thiocyanate solutions and held in closed containers for varying periods was a little slower to germinate than seed dipped in ethylene chlorhydrin. However, the development of the seed given the 1-percent treatment soon equaled that of the ethylene chlorhydrin. The 2-percent sodium-thiocyanate treatment gave the most uniform results.

SEASON OF 1929–30

As in the previous season, the potatoes used in the 1929–30 chemical-treatment studies were grown at Presque Isle, Maine, and were harvested September 25.

TABLE 4

FOUND AT END OF BULLETIN.

From the information obtained in the 1928–29 studies it seemed desirable to determine the relative merits of the ethylene-chlorhydrin and sodium-thiocyanate treatments for hastening germination of potato tubers during their rest period. A method requiring gassing the sets in a closed container for a period of from 6 to 48 hours seemed obviously impracticable for commercial adoption and use. It was felt that if a method of soaking which would be approximately as effective as the dipping-gassing method could be developed the treating process would be greatly simplified. As such a method of soaking had been employed by Denny (*4*), his work paved the way for further study, and the 1929–30 treatments were definitely planned to permit careful study of the possibilities of the soaking method. Inasmuch as in previous studies sets dipped in a 6-percent solution of ethylene chlorhydrin and held in a closed container for 24 hours had given satisfactory results, this treatment was used as a standard of comparison with results obtained from sets soaked for varying intervals in different strengths of sodium thiocyanate.

Eight lots of 30 sets each of 23 varieties were treated as follows:

Lot 1.—Dipped in a 6-percent solution of ethylene chlorhydrin and gassed 24 hours.
Lot 2.—Soaked in a 1-percent solution of sodium thiocyanate 1 hour.
Lot 3.—Soaked in a 1½-percent solution of sodium thiocyanate 1 hour.
Lot 4.—Soaked in a 2-percent solution of sodium thiocyanate 1 hour.
Lot 5.—Soaked in a 1-percent solution of sodium thiocyanate 1½ hour.
Lot 6.—Soaked in a 1½-percent solution of sodium thiocyanate 1½ hours.
Lot 7.—Soaked in a 2-percent solution of sodium thiocyanate 1½ hours.
Lot 8.—Check (untreated).

The lots soaked in the sodium-thiocyanate solution were treated at the same time as those that were dipped in the ethylene-chlorhydrin solution and were planted in an Arlington Farm greenhouse the following day, as was also the dipped-gassed lot. The results obtained from the treatment of the 23 varieties are presented in table 4.

A study of these data indicates considerable variability in the response of different varieties to the chemical treatments. It is also apparent that some sets were rather seriously injured by the treatment. This is particularly true of those treated October 31 and November 1, the germination percentage of which is given in table 4. The injury was directly attributable to high day and night temperatures, which prevailed during treatment and subsequent planting. The most serious injury was to seed treated with ethylene chlorhydrin and held 24 hours in a tight container. Comparatively little injury was sustained in the case of lots soaked in the sodium-thiocyanate solutions except in the case of the 1½- and 2-percent solutions, especially during the longer treatments.

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The varieties involved in the hot-weather treatment period, October 31 to November 2, were Adirondack, American Giant, Early Rose, and Green Mountain. The results of the experiment serve to corroborate those obtained by Denny (*5*) in the treatment of potatoes during extremely hot weather.

Exclusive of the 4 varieties injured by high temperatures in the process of treatment during the dates mentioned, the following varieties responded most promptly: Burbank, Charles Downing, Early Manistee, Early Ohio, Early Rose treated November 12 and 13, Early St. George, Dakota Red, McCormick, Noroton Beauty, Northern Spy, Prolific, Queen-of-the-Valley, and White Ohio. A more critical analysis of these data indicates that 93 percent of the Prolific sets treated with ethylene chlorhydrin germinated in 16 days. White Ohio showed 90-percent germination in 23 days and Early Manistee and Early St. George 83 percent each in 17 days.

The most successful treatments in 1929, based on promptness of germination of treated seed as compared with untreated sets as presented in table 5, indicate that in two cases the untreated seed did not show any germination at the end of 36 and 37 days, while during the same period the treated seed gave a germination of 93 and 99.1 percent, respectively.

TABLE 5.—*Physiological responses of potato sets to chemical treatments, 1929–30*

Variety	Days from treatment	Average germination from all treatments	Germination from untreated sets	Variety	Days from treatment	Average germination from all treatments	Germination from untreated sets
	Number	*Percent*	*Percent*		*Number*	*Percent*	*Percent*
Charles Downing	34	87.4	12	Early Manistee	36	77.1	43
Dakota Red	34	86.6	7	Queen-of-the-Valley	37	99.1	0
White Ohio	36	93.0	0	Northern Spy	37	78.9	17

Table 6, consisting of data compiled from table 4, indicates the time between treatment of tuber sets and the resultant 90-percent germination, in comparison with untreated sets. Where a lower percentage of germination is recorded, either the maximum percentage is indicated or the maximum percentage recorded during the total period of observation. In a number of instances where less than 100 percent is recorded, complete germination was attained a few days later.

A comparison of the relative germination of treated and untreated potato sets reveals that those of Beauty of Hebron, Early St. George, Queen-of-the-Valley, and White Ohio, which were treated with ethylene chlorhydrin, showed a germination of 90 percent or over before any sign of germination was noted in the untreated sets. The time intervals were 24, 22, 26, and 23 days, respectively. Early Manistee, Dakota Red, and the White-Eyed Peachblow gave 93, 90, and 100 percent germination in 22, 31, and 21 days, respectively, from the sets treated with ethylene chlorhydrin, as against 3, 7, and 7 percent germination from the untreated sets.

Nine of the nineteen varieties showed a quicker response from the ethylene-chlorhydrin treatment as against 3 varieties giving quicker germination from the sodium-thiocyanate treatment, while the remaining 7 showed the same acceleration from one or more of the sodium-thiocyanate concentration or time treatments as from ethylene chlorhydrin.

TABLE 6.—*Percentage of germination of potato sets and number of days required after chemical treatment to reach 90 percent or over*[1] *and resultant germination of untreated sets during the 1929–30 season*

Variety	Germination when treated with—																				
	Ethylene chlorhydrin			Sodium thiocyanate																	
	6 percent for 24 hours		Check	1 percent for 1 hour		Check	1.5 percent for 1 hour		Check	2 percent for 1 hour		Check	1 percent for 1.5 hours		Check	1.5 percent for 1.5 hours		Check	2 percent for 1.5 hours		Check
	Days	*Pct.*	*Pct.*	*Days*	*Pct.*	*Pct.*	*Days*	*Pct.*	*Pct.*	*Days*	*Pct.*	*Pct.*	*Days*	*Pct.*	*Pct.*	*Days*	*Pct.*	*Pct.*	*Days*	*Pct.*	*Pct.*
Beauty of Hebron	24	93	0	32	90	30	36	97	77	36	87	77	32	93	30	32	80	30	36	67	77
Burbank	29	90	47	41	87	87	29	80	47	41	73	87	23	97	7	29	83	47	32	77	53
Charles Downing	31	96	8	31	96	8	39	84	28	34	100	12	31	100	8	39	92	28	39	64	28
Early Manistee	22	93	3	48	83	93	48	83	93	48	97	93	28	93	17	48	93	93	48	90	93
Early Ohio	31	90	17	31	93	17	37	97	50	37	93	50	37	100	50	37	93	50	37	44	50
Early Rose [2]	26	90	80	35	83	93	35	77	93	38	67	93	35	83	93	35	73	93	35	67	93
Early St. George	22	90	0	28	93	10	36	93	67	48	83	87	36	97	67	36	93	67	36	97	67
Dakota Red	31	90	7	31	97	7	39	90	10	39	80	10	34	90	7	46	90	30	39	87	10
Keeper	21	88	20	25	92	20	30	96	44	30	88	44	25	92	20	25	92	20	30	92	44
McCormick	27	90	17	50	90	67	50	83	67	50	53	67	45	90	60	45	73	60	50	60	67
Noroton Beauty	32	90	77	32	90	77	32	90	77	36	93	87	32	97	77	32	93	77	36	97	87
Northern Spy	49	80	20	49	87	20	37	93	17	49	90	20	49	83	20	37	87	17	49	73	20
Prolific	16	93	13	30	97	70	30	90	70	45	90	100	30	97	70	35	93	90	45	83	100
Queen-of-the-Valley	26	90	0	26	97	0	31	97	0	31	97	0	31	93	0	31	90	0	37	100	0
Scotch Rose	33	93	20	30	97	7	38	97	27	38	90	27	33	93	20	38	97	27	42	90	70
White-Eyed Peachblow	21	100	7	27	90	13	32	100	33	32	97	33	27	100	13	32	90	33	32	97	33
White Ohio	23	90	0	33	100	0	33	97	0	36	87	0	33	100	0	33	90	0	36	70	0
White Rose	35	90	80	35	97	80	35	93	80	47	93	93	39	93	87	47	87	93	47	93	93
White Star	31	90	37	34	90	43	39	90	57	46	73	73	31	90	37	34	87	43	46	90	70
Average	27.9	90.8	23.8	34.1	92.1	39.0	36.1	90.9	49.3	40.0	85.8	55.3	33.2	93.7	35.9	36.4	88.2	47.3	39.6	80.9	55.5

[1] Whenever less than 90 percent is recorded the figure represents the maximum germination within the total period of observation of either the treated or check lots.
[2] Early Rose treated Nov. 12, 1929.

Perhaps one of the most interesting results is found in the reaction of Prolific in which the ethylene-chlorhydrin treated sets gave 93 percent germination in 16 days, while the check lot showed 13 percent germination. This would seem to indicate that the Prolific variety has a relatively short rest period. Other examples of a comparatively short rest period are found in Early Rose (second lot), Noroton Beauty, White Rose, Burbank, and White Star. The data presented in these instances indicate the desirability of determining the relative length of the rest period of the leading commercial varieties of potatoes. When the average time interval is compared for the different treatments of the 19 varieties, it is found that the 6-percent ethylene-chlorhydrin treated sets required the shortest period of days, 27.9, as compared with 33.2 days in the case of those treated 1½ hours in a 1-percent sodium-thiocyanate solution, which was the next shortest time interval to give 90 percent, or approximately 90 percent, germination.

SEASON OF 1930-31

In the 1930–31 studies 11 varieties were used. The sodium-thiocyanate treatments were restricted to a 1-hour soaking in 1- and 1½-percent solutions and a 1½-hour immersion in a 1-percent solution. Further modification consisted in a substitution of a 4-percent solution for a 6-percent solution of ethylene chlorhydrin for general comparison with the sodium-thiocyanate treatments. In three instances a 6-percent ethylene-chlorhydrin solution was used for comparison with the 4-percent solution.

The varieties American Giant, Beauty of Hebron, Burbank (Low-top), Early Ohio, Dakota Red, and Prolific were harvested September 8, 1930, and the Green Mountain, Irish Cobbler, Queen-of-the-Valley, Rural New Yorker No. 2, and Triumph on September 22. All of the varieties were grown at Aroostook Farm, Presque Isle, Maine.

The data in table 7 represent the calendar order of treatment of the several varieties.

These figures indicate a decided hastening of germination as compared with the checks of the varieties Rural New Yorker No. 2, American Giant, Burbank (Low-top), Green Mountain, Queen-of-the-Valley, Early Ohio, Dakota Red, and Triumph.

The data on the comparative efficacy of the ethylene-chlorhydrin and sodium-thiocyanate treatments as indicated in table 7 show that the 6-percent ethylene-chlorhydrin treatment resulted in a quicker germination response than the 4-percent treatment. Comparison of the response from the 4-percent ethylene-chlorhydrin treatment and the 1-percent 1-hour sodium-thiocyanate treated seed shows a decidedly quicker response in 6 of the 11 lots and somewhat greater in 2 other lots.

TABLE 7.—*Varietal responses of potato seed pieces treated with chemicals to break the rest period, 1930*

Variety and chemical used	Date treated	Date planted	Concentration	Time of treatment	Rate of germination in—															
					15 days	16 days	17 days	18 days	19 days	20 days	21 days	22 days	23 days	24 days	25 days	26 days	27 days	28 days	29 days	30 days
			Percent	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Irish Cobbler:																				
Ethylene chlorhydrin	Oct. 27	Oct. 28	6	[1] 24						97			100							
Do	do	do	4	[1] 24						87			100							
Sodium thiocyanate	do	do	1	1						70			80			90		90		
Do	do	do	1.5	1						43			67			73		77		
Do	do	do	1	1.5						33			70			83		93		
Untreated		do								13			27			43		50		
Triumph:																				
Ethylene chlorhydrin	Oct. 28	Oct. 29	6	[1] 24		7			90			100								
Do	do	do	4	[1] 24		3			47			90			100					
Sodium thiocyanate	do	do	1	1					30			43			70					100
Do	do	do	1.5	1					10			23			43					70
Do	do	do	1	1.5					17			63			83					100
Untreated		do										3			3					13
Rural New Yorker No. 2:																				
Ethylene chlorhydrin	Oct. 28	do	6	[1] 24		3			53			70			83					90
Do	do	do	4	[1] 24		7			40			47			50					60
Sodium thiocyanate	do	do	1	1		3			37			40			50					57
Do	do	do	1.5	1					13			20			20					30
Do	do	do	1	1.5					3			33			43					50
Untreated		do							3			3			3					3
Early Ohio:																				
Ethylene chlorhydrin	Oct. 29	Oct. 30	4	[1] 24							13			23					37	
Sodium thiocyanate	do	do	1	1							3			3					20	
Do	do	do	1.5	1										13					20	
Do	do	do	1	1.5										7					20	
Untreated		do																		
Beauty of Hebron:																				
Ethylene chlorhydrin	Oct. 29	do	4	[1] 24							50			57					67	
Sodium thiocyanate	do	do	1	1							10			13					53	
Do	do	do	1.5	1							7			23					40	
Do	do	do	1	1.5							10			20					47	
Untreated		do												10					13	
Green Mountain:																				
Ethylene chlorhydrin	Oct. 30	Oct. 31	4	[1] 24			20			20			27					57		
Sodium thiocyanate	do	do	1	1			10			27			67					90		
Do	do	do	1.5	1			7			17			43					70		
Do	do	do	1	1.5						17			53					83		
Untreated		do											3					7		

[1] Dipped and then confined in a tight container for time indicated.

TABLE 7.—*Varietal responses of potato seed pieces treated with chemicals to break the rest period, 1930*—Continued

Variety and chemical used	Date treated	Date planted	Concentration	Time of treatment	Rate of germination in—													Decayed seed
					31 days	32 days	33 days	34 days	35 days	36 days	37 days	38 days	39 days	40 days	41 days	42 days	43 days	44 days	
			Percent	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Percent*
Irish Cobbler:																			
Ethylene chlorhydrin	Oct. 28	Oct. 28	6	[1] 24															
Do	do	do	4	[1] 24															
Sodium thiocyanate	do	do	1	1	100														
Do	do	do	1.5	1	87			90			100								0
Do	do	do	1	1.5	97			97											7
Untreated		do			57			70			70								
Triumph:																			
Ethylene chlorhydrin	Oct. 28	Oct. 29	6	[1] 24															
Do	do	do	4	[1] 24															
Sodium thiocyanate	do	do	1	1															
Do	do	do	1.5	1			83			100									
Do	do	do	1	1.5															20
Untreated		do					20			20									
Rural New Yorker No. 2:																			
Ethylene chlorhydrin	Oct. 28	do	6	[1] 24			97			97									0
Do	do	do	4	[1] 24			63			80									0
Sodium thiocyanate	do	do	1	1			70			70									0
Do	do	do	1.5	1			50			70									0
Do	do	do	1	1.5			77			77									0
Untreated		do					3			3									
Early Ohio:																			
Ethylene chlorhydrin	Oct. 29	Oct. 30	4	[1] 24					63				73			83		90	10
Sodium thiocyanate	do	do	1	1					43				80			83		100	
Do	do	do	1.5	1					43				80			87		100	
Do	do	do	1	1.5					50				80			90		100	
Untreated		do							3				3			7		13	0
Beauty of Hebron:																			
Ethylene chlorhydrin	Oct. 29	do	4	[1] 24					80				80			90		93	7
Sodium thiocyanate	do	do	1	1					77				97			100			
Do	do	do	1.5	1					53				70			87		100	
Do	do	do	1	1.5					63				83			87		100	
Untreated		do							23				33			40		53	0
Green Mountain:																			
Ethylene chlorhydrin	Oct. 30	Oct. 31	4	[1] 24				83				83			90				0
Sodium thiocyanate	do	do	1	1				93				97			100				
Do	do	do	1.5	1				90				100							
Do	do	do	1	1.5				100											
Untreated		do						7				10			10				7

[1] Dipped and then confined in a tight container for time indicated.

Variety and chemical used	Date treated	Date planted	Concentration	Time of treatment	Rate of germination in—														
					15 days	16 days	17 days	18 days	19 days	20 days	21 days	22 days	23 days	24 days	25 days	26 days	27 days	28 days	29 days	30 days
Burbank (Low-top):			*Percent*	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Ethylene chlorhydrin	Oct. 30	Oct. 31	4	[1] 24			13			13			17					37		
Sodium thiocyanate	do	do	1	1			7			7			37					70		
Do	do	do	1.5	1			3			7			17					43		
Do	do	do	1	1.5			10			13			30					77		
Untreated		do																		
American Giant:																				
Ethylene chlorhydrin	Nov. 4	Nov. 5	4	[1] 24	20			50					57						73	
Sodium thiocyanate	do	do	1	1				7					37						77	
Do	do	do	1.5	1									17						57	
Do	do	do	1	1.5									10						50	
Untreated		do																		
Prolific:																				
Ethylene chlorhydrin	Nov. 4	do	4	[1] 24	3			23					63						70	
Sodium thiocyanate	do	do	1	1				3					27						70	
Do	do	do	1.5	1				3					13						47	
Do	do	do	1	1.5	7			13					33						70	
Untreated		do											10						20	
Dakota Red:																				
Ethylene chlorhydrin	Nov. 6	Nov. 7	4	[1] 24		7					27			30			40			
Sodium thiocyanate	do	do	1	1		3					17			43			70			
Do	do	do	1.5	1		3					7			33			53			
Do	do	do	1	1.5		10					20			37			57			
Untreated		do												3			3			
Queen-of-the-Valley:																				
Ethylene chlorhydrin	Nov. 6	do	4	[1] 24																
Sodium thiocyanate	do	do	1	1		20					73			17			17			
Do	do	do	1.5	1		3					37			97			97			
Do	do	do	1	1.5		20					53			67			73			
Untreated		do												87			90			
														3			3			

[1] Dipped and then confined in a tight container for time indicated.

TABLE 7.—*Varietal responses of potato seed pieces treated with chemicals to break the rest period, 1930*—Continued

Variety and chemical used	Date treated	Date planted	Concentration	Time of treatment	Rate of germination in—														Decayed seed
					31 days	32 days	33 days	34 days	35 days	36 days	37 days	38 days	39 days	40 days	41 days	42 days	43 days	44 days	
			Percent	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Percent*
Burbank (Low-top):																			
Ethylene chlorhydrin	Oct. 30	Oct. 31	4	[1] 24	------	------	------	53	------	------	------	77	------	------	80	------	------	------	0
Sodium thiocyanate	---do----	---do----	1	1	------	------	------	77	------	------	------	100	------	------	------	------	------	------	------
Do	---do----	---do----	1.5	1	------	------	------	70	------	------	------	87	------	------	93	------	------	------	0
Do	---do----	---do----	1	1.5	------	------	------	97	------	------	------	------	------	------	------	------	------	------	3
Untreated	----------	---do----	------	------	------	------	------	7	------	------	------	10	------	------	10	------	------	------	3
American Giant:																			
Ethylene chlorhydrin	Nov. 4	Nov. 5	4	[1] 24	------	------	93	------	------	97	------	100	------	------	------	------	------	------	------
Sodium thiocyanate	---do----	---do----	1	1	------	------	97	------	------	97	------	100	------	------	------	------	------	------	------
Do	---do----	---do----	1.5	1	------	------	80	------	------	83	------	93	------	------	------	------	------	------	7
Do	---do----	---do----	1	1.5	------	------	83	------	------	97	------	100	------	------	------	------	------	------	------
Untreated	----------	---do----	------	------	------	------	3	------	------	7	------	10	------	------	------	------	------	------	0
Prolific:																			
Ethylene chlorhydrin	Nov. 4	---do----	4	[1] 24	------	------	80	------	------	83	------	87	------	------	------	------	------	------	13
Sodium thiocyanate	---do----	---do----	1	1	------	------	97	------	------	100	------	------	------	------	------	------	------	------	------
Do	---do----	---do----	1.5	1	------	------	80	------	------	80	------	97	------	------	------	------	------	------	3
Do	---do----	---do----	1	1.5	------	------	90	------	------	100	------	------	------	------	------	------	------	------	------
Untreated	----------	---do----	------	------	------	------	27	------	------	33	------	60	------	------	------	------	------	------	0
Dakota Red:																			
Ethylene chlorhydrin	Nov. 6	Nov. 7	4	[1] 24	63	------	------	67	------	67	------	------	------	------	------	------	------	------	3
Sodium thiocyanate	---do----	---do----	1	1	90	------	------	93	------	100	------	------	------	------	------	------	------	------	------
Do	---do----	---do----	1.5	1	87	------	------	90	------	100	------	------	------	------	------	------	------	------	------
Do	---do----	---do----	1	1.5	80	------	------	80	------	90	------	------	------	------	------	------	------	------	10
Untreated	----------	---do----	------	------	10	------	------	13	------	17	------	------	------	------	------	------	------	------	3
Queen-of-the-Valley:																			
Ethylene chlorhydrin	Nov. 6	---do----	4	[1] 24	27	------	------	33	------	60	------	------	------	------	------	------	------	------	0
Sodium thiocyanate	---do----	---do----	1	1	100	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Do	---do----	---do----	1.5	1	90	------	------	90	------	97	------	------	------	------	------	------	------	------	3
Do	---do----	---do----	1	1.5	100	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Untreated	----------	---do----	------	------	3	------	------	7	------	10	------	------	------	------	------	------	------	------	14

[1] Dipped and then confined in a tight container for time indicated.

The data presented in table 8 are a condensation of the final germination percentages recorded during the period of observation. These figures represent the end result, as it were, but do not indicate the rate of germination acceleration of the treated seed as compared with the checks or with different chemical solution concentrations and time intervals of treatment. The data do, however, serve to furnish the reader with a condensed summary of the results obtained. As has been previously mentioned, the 6-percent ethylene-chlorhydrin treatments show the greatest acceleration. Of the three varieties receiving such treatment the Triumph and Irish Cobbler show the most marked response. The former variety showed 90-percent germination in 19 days before the check sets showed any germination while the Irish Cobbler gave a 97-percent germination in 20 days, but at that time the check had shown a 13-percent germination. Apparently the tuber rest period of the Irish Cobbler is shorter or is more easily affected by chemical treatment than that of the Triumph. This is all the more evident in that the untreated Triumph sets did not show 13-percent germination until 30 days from date of starting the experiment. A similar comparison of the relative depth of rest period of the Rural New Yorker No. 2 variety shows that only 3-percent germination of the untreated sets occurred during the 36-day observation period. Another striking example of this sort is noted in the Early Ohio, Irish Cobbler, and Prolific in which the untreated sets of the first had only shown a 3-percent germination in 35 days, 7 percent in 42 days, and 13 percent in 44 days, whereas the Irish Cobbler check lot showed 70-percent germination in 34 days and the Prolific 60 percent in 38 days. These examples serve to indicate a distinct variability either in the length or depth of the rest period of different varieties of potatoes.

TABLE 8.—*Percentage of germination of potato sets and number of days required after chemical treatment to reach 90 percent or over* [1] *and resultant germination of untreated sets during the 1930–31 season*

Variety	Germination when treated with—														
	Ethylene chlorhydrin						Sodium thiocyanate								
	6 percent for 24 hours		Check	4 percent for 24 hours		Check	1 percent for 1 hour		Check	1½ percent for 1 hour		Check	1 percent for 1½ hours		Check
	Dy.	*Pct.*	*Pct.*	*Dy.*	*Pct.*	*Pct.*	*Dy.*	*Pct.*	*Pct.*	*Dy.*	*Pct.*	*Pct.*	*Dy.*	*Pct.*	*Pct.*
American Giant				32	93	3	33	97	3	38	93	10	38	97	7
Beauty of Hebron				42	90	40	39	97	33	44	100	53	44	100	53
Burbank (Low-top)				41	80	10	38	100	10	41	93	10	34	97	7
Early Ohio				44	90	13	44	100	13	44	100	13	42	90	7
Irish Cobbler	20	97	13	23	100	27	26	90	43	34	90	70	28	93	50
Dakota Red				34	67	13	31	90	10	34	90	13	36	90	17
Green Mountain				41	90	10	28	90	7	34	90	7	34	100	7
Prolific				38	87	60	33	97	27	38	97	60	33	90	27
Queen-of-the-Valley				36	60	10	24	97	3	31	90	3	27	90	3
Rural New Yorker No. 2	30	90	3	36	80	3	36	70	3	36	70	3	33	77	3
Triumph	19	90	0	22	90	3	30	100	13	36	100	20	30	100	13

[1] Wherever less than 90 percent is recorded, the figure represents the maximum germination within the total period of observation.

In a later trial made for the purpose of determining the best period of treatment with sodium thiocyanate three varieties were used, Green

Mountain, Irish Cobbler, and Triumph. The length of immersion was 1, 1½, and 2 hours in a 1-percent solution. Seed treated in this manner was compared with seed dipped in a 6-percent ethylene-chlorhydrin solution and confined in a tight container for 24 hours, and also with untreated seed.

The results, which are presented in table 9, corroborate the general behavior of previous treatments. Comparing the average germination of the three varieties, the ethylene chlorhydrin shows a 99-percent germination in 28.7 days, as against 98-, 99-, and 96.7-percent germination in 30, 30, and 32.7 days from the 1-, 1½-, and 2-hour treatments, and 62.3 percent in 32.7 days from the untreated seed.

Of the five varieties showing a final advantage from the sodium-thiocyanate treatments, the Burbank and Dakota Red are the most outstanding.

TABLE 9.—*Varietal responses of potato seed pieces treated with chemicals to break the rest period*

[Sets treated Dec. 2 and planted Dec. 3, 1930][1]

Variety and chemical used	Concentration	Time of treatment	Rate of germination in—				Decayed seed
			20 days	20 days	30 days	34 days	
Irish Cobbler:	*Percent*	*Hours*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Ethylene chlorhydrin	6	24	17	80	100		
Sodium thiocyanate	1	1	23	90	100		
Do	1	1.5	7	83	100		
Do	1	2	7	83	100		
Check			7	13	37		6
Triumph:							
Ethylene chlorhydrin	6	24	73	97			3
Sodium thiocyanate	1	1	20	93	97		3
Do	1	1.5	10	80	97		3
Do	1	2		40	60	93	7
Check				30	97	100	
Green Mountain:							
Ethylene chlorhydrin	6	24	3	90	100		
Sodium thiocyanate	1	1	7	90	97		3
Do	1	1.5	3	77	100		
Do	1	2		57	83	97	3
Check				10	23	50	0

[1] The average percentage of germination under the various treatments was as follows: Ethylene chlorhydrin, 99 percent in 28.7 days; sodium thiocyanate, 98 percent in 30 days when seed pieces were treated 1 hour; 99 percent in 30 days when seed pieces were treated 1.5 hours; and 96.7 percent in 32.7 days when seed pieces were treated 2 hours. The untreated, or check, plot averaged 62.3 percent germination in 32.7 days.

SUMMER AND FALL OF 1931

In order to secure additional information on the efficacy of ethylene-chlorhydrin gas in breaking the rest period of mature potatoes, 7 varieties grown at the Arlington Experiment Farm, which were harvested August 5 and held in a storage temperature of about 45° F., were gassed August 26 and 27. The concentration of the gas was at the rate of 1 cc per liter of air space, and the period of treatment was 24 hours. The lots treated consisted of whole and cut sets. One lot of whole tubers of each variety was dipped in water prior to treatment, while a second lot was treated dry. On removal from the airtight chamber they were held in a 60° F. storage room for 15 days, after which they were transferred to a storage room held at 70° F. until germination notes were completed. The data obtained are presented in table 10.

Wet-treated tubers of the Charles Downing variety germinated more promptly than any other lot. Four of the seven varieties showed quicker germination from the wet tubers than from dry-treated tubers, while in the case of the Burbank, Rural New Yorker No. 2, and Triumph the reverse was true. Some lots of cut seed showed decay as a result of injury from the treatment.[3]

Owing to scarcity of seed, it was possible to run checks only with the first three varieties.

TABLE 10.—*Ethylene chlorhydrin gas treatment of seven varieties of potatoes with 1 cc per liter of air space for 24 hours*

[Potatoes harvested Aug. 5 and treated Aug. 26–27, 1931]

Variety and number of tubers	Whole or cut	Dry or wet	Rate of germination in—												Decay
			18 days	21 days	25 days	29 days	33 days	36 days	39 days	43 days	46 days	50 days	66 days	74 days	
Irish Cobbler:			Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
25	Whole	Dry	24	30	40	60	60	72	72	84	100				
25	do	Wet	56	84	84	100									
25	Cut [1]	Dry	10	20	30	34	34	38	52						22
25	Whole [2]	do	0	0	0	0	0	4	24	44	96	100			
25	Whole [3]	do	0	0	0	0	0	4	12	44	64	76	100		
Triumph:															
25	Whole	do	28	56	68	92	96	96	96						
25	do	Wet	52	76	84	92	92	92	96						
25	Cut [1]	Dry	12	26	38	42	46	54	62						20
25	Whole [3]	do	4	4	4	24	36	52	60	68	76	92	100		
Early Ohio:															
25	Whole	do	4	8	20	44	44	48	48	48	60	80	92	100	
25	do	Wet	32	44	68	68	68	72	72	80	88	100			
25	Cut [1]	Dry	2	2	6	22	24	28	38						32
25	Whole [3]	do	0	4	4	4	4	4	12	12	16	24	64	92	8
Katahdin:															
20	Whole	do	95	95	95	95	95	100							
20	do	Wet	95	95	95	100									
25	Cut [1]	Dry	36	50	56	72	72	78	78						12
Charles Downing:															
20	Whole	do	30	65	65	85	85	85	85	100					
20	do	Wet	95	100											
25	Cut [1]	Dry	28	28	44	70	76	82	90						6
Burbank:															
20	Whole	do	25	35	40	70	70	75	95						
20	do	Wet	65	65	85	85	90	90	90						
25	Cut [1]	Dry	6	18	38	58	60	60	78						10
Rural New Yorker No. 2:															
20	Whole	do	75	80	80	85	85	95	95	95	100				
20	do	Wet	85	90	90	90	90	90	90						
25	Cut [1]	Dry	12	34	46	60	60	62	68						24

[1] No. 2 tubers cut in two.
[2] No. 1 tubers whole, untreated check.
[3] No. 2 tubers whole, untreated check.

On September 21 four lots each of Irish Cobbler and Triumph potatoes were treated with ethylene chlorhydrin at the rate of one half cc of the liquid to each liter of air space, or at the rate of slightly over 14 cc per cubic foot of air space. All lots consisted of whole tubers which had been harvested September 12. Two lots of each variety were gassed for 24 hours and the other 2 for 48 hours. In each pair of treatments one lot was thoroughly moistened before sacking. All were treated in burlap bags, in order to be comparable with car-lot treatment of sacked potatoes. The receptacle used was a galvanized-iron ash can, the cover of which was hermetically sealed with glaziers' putty. On removal of the tubers they were held at a room temperature of 70° F. for germination.

[3] The injury, when not severe enough to cause decay of the seed piece, was in the nature of retarded germination and a yellowing or bronzing of the foliage and terminal portion of the stem.

A study of the data preseated in table 11 shows decided shortening of the rest period as compared with the check or untreated lot.

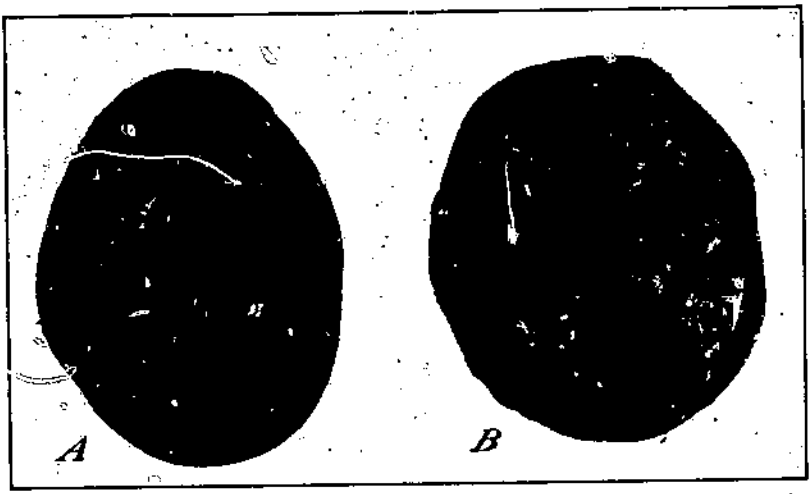

FIGURE 1.—Irish Cobbler potatoes: *A*, Treated September 21, 1931, in a 0.5-cc-per-liter concentration of ethylene chlorhydrin gas for 24 hours: *B*, tuber untreated. Photographed 13 days after treatment.

Slightly quicker germination was obtained from Triumph than from Irish Cobbler. The 24-hour exposure of the moistened lot of Triumphs and the 48-hour exposure of the dry lot showed 64 and 52

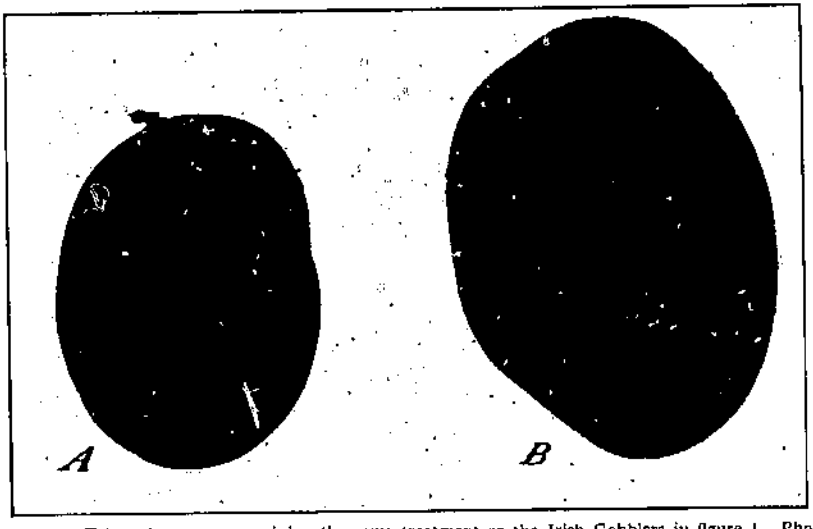

FIGURE 2.—Triumph potatoes receiving the same treatment as the Irish Cobblers in figure 1. Photographed 13 days after treatment.

percent of germinating tubers 14 days after treatment. The dry lot gave 100-percent germination in 21 days, against 25 days in the wet-lot treatment. No germination was noted in either check lot 29 days from treatment, while 3 days later each lot had 1 germinated

tuber. On the fifty-third day from treatment the check lot of Irish Cobbler tubers had given 100-percent germination, but the Triumph showed only 20 percent. Figures 1 and 2 show the stage of germination of the treated tubers 13 days after treatment. Figures 3 and 4 show, by graphs, the rate of germination of the Irish Cobbler and Triumph treated September 21.

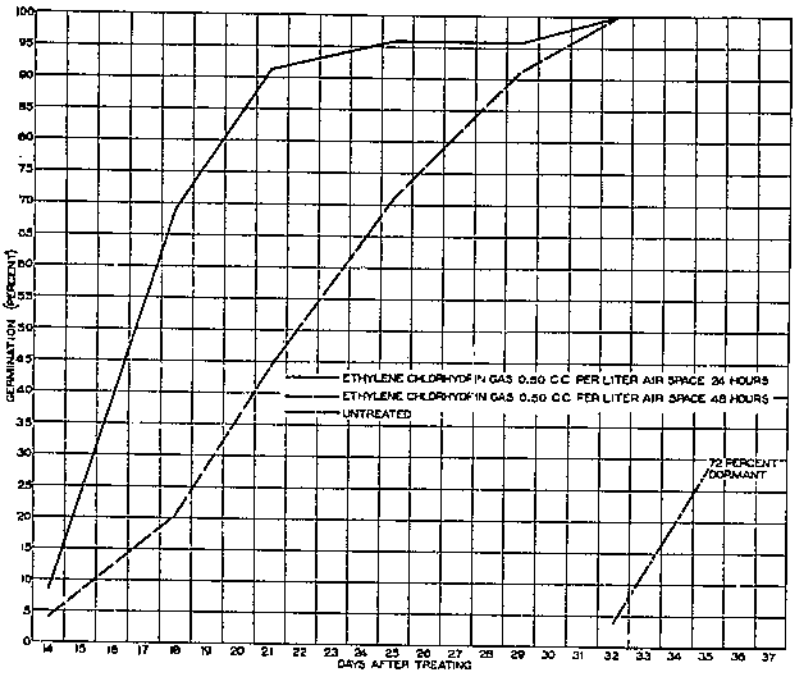

FIGURE 3.—Rate of germination of treated and untreated Irish Cobbler tubers harvested September 12 and treated September 21–22, 1931, with ethylene chlorhydrin. Tubers placed in 70° F. room immediately after treatment.

TABLE 11.—*Ethylene chlorhydrin gas treatment with one half cc per liter of air space, using in each test 25 tubers of the Irish Cobbler and Triumph varieties*

[Potatoes harvested Sept. 12 and treated Sept. 21, 1931]

Variety and condition of whole tuber	Duration of treatment	Rate of germination in—													
		14 days	18 days	21 days	25 days	29 days	32 days	35 days	39 days	42 days	46 days	49 days	53 days	60 days	67 days
Irish Cobbler:	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Dry	24	----	20	44	68	92	92	100	----	----	----	----	----	----	----
Wet	24	8	68	92	96	96	100	----	----	----	----	----	----	----	----
Dry	48	----	28	56	68	84	88	100	----	----	----	----	----	----	----
Wet	48	4	20	44	72	92	100	----	----	----	----	----	----	----	----
Check	----	----	----	----	----	----	4	28	52	72	84	96	100	----	----
Triumph:															
Dry	24	24	48	76	92	96	100	----	----	----	----	----	----	----	----
Wet	24	64	88	96	100	----	----	----	----	----	----	----	----	----	----
Dry	48	52	96	100	----	----	----	----	----	----	----	----	----	----	----
Wet	48	16	56	72	88	96	100	----	----	----	----	----	----	----	----
Check	----	----	----	----	----	----	4	8	8	8	8	8	20	64	80	92

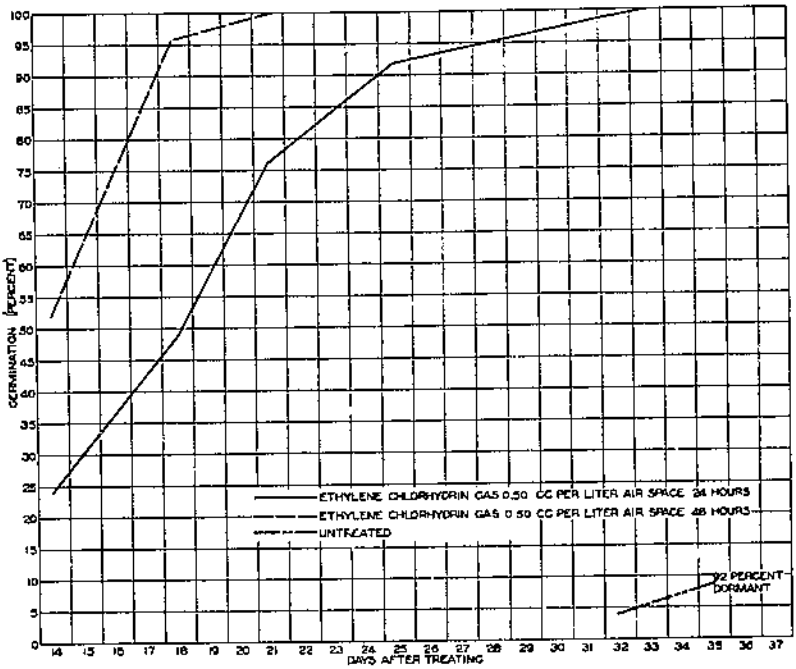

FIGURE 4.—Rate of germination of treated and untreated Triumph tubers harvested September 12 and treated September 21–22, 1931, with ethylene chlorhydrin. Tubers placed in 70° F. room immediately after treatment.

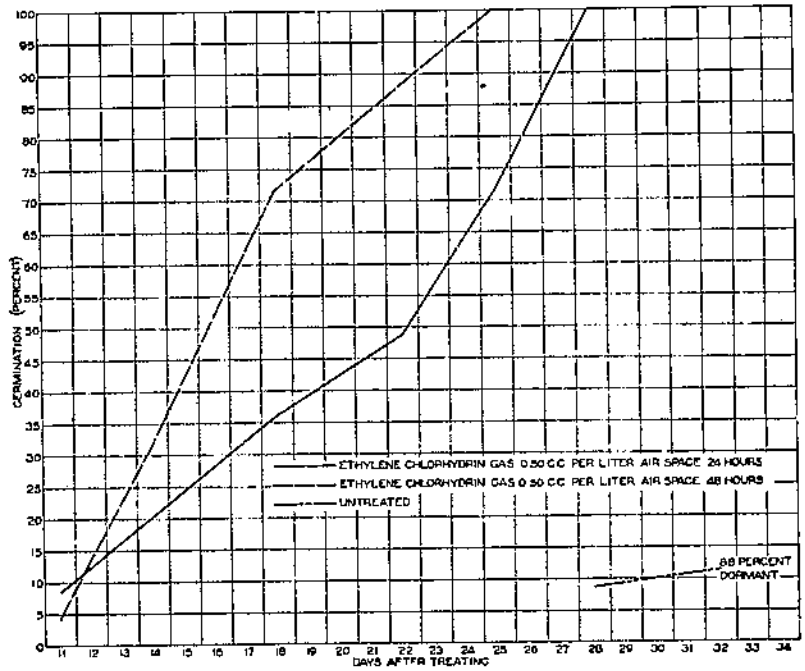

FIGURE 5.—Rate of germination of Irish Cobbler tubers harvested September 12 and treated September 28–29, 1931, with ethylene chlorhydrin. Tubers placed in 70° F. room immediately after treatment.

The treatments of September 21 were repeated on the same varieties 1 week later. The results obtained, as presented in table 12, show that in 3 of the 4 Irish Cobbler comparative treatments the time interval between treatment and a 90-percent germination was shorter than in the September 21 treatment. A similar comparison of the Triumph data shows a 50–50 result. If, however, the average time interval between treatment and the 90-percent objective is compared,

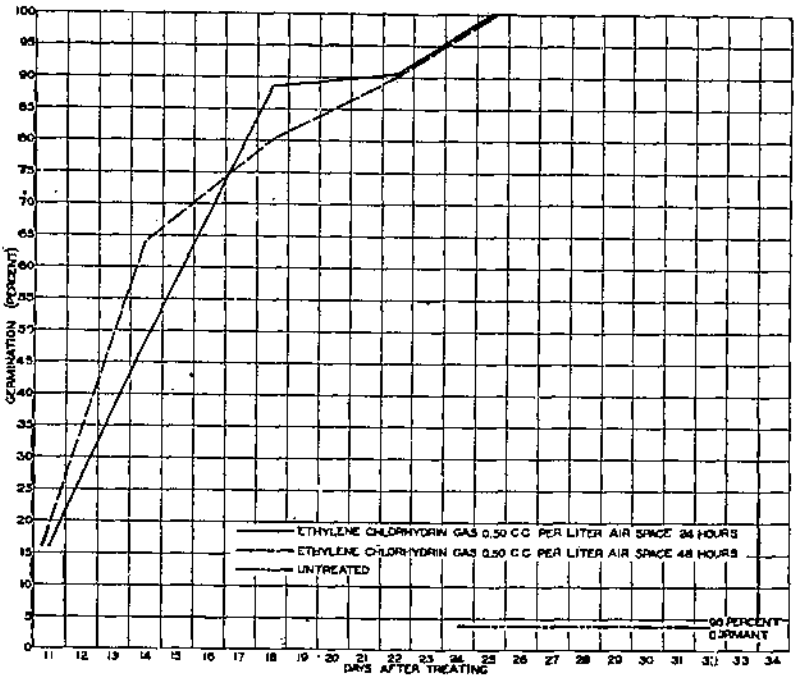

FIGURE 6.—Rate of germination of treated and untreated Triumph tubers harvested September 12 and treated September 28–29, 1931, with ethylene chlorhydrin. Tubers placed in 70° F. room immediately after treatment.

it is found that the resultant averages are remarkably close. For example, the average time interval of both the Irish Cobbler and Triumph in the treatment given September 21 was 25.9 days, with an average germination of 94.5 percent, as compared with 24.6 days and 95-percent germination from the treatment given September 28. During the same period the average germination of the untreated sets was 3.5 and 3.0 percent, respectively. In other words, the data indicate, as might be expected, the natural passage of the rest period. Figures 5 and 6 show, by graphs, the rate of germination of the Irish Cobbler and Triumph treated September 28.

TABLE 12.—*Ethylene chlorhydrin gas treatment with one half cc per liter of air space, using in each test 25 tubers of the Irish Cobbler and Triumph varieties*

[Potatoes harvested Sept. 12 and treated Sept. 28, 1931]

Variety and condition of whole tubers	Duration of treatment	Rate of germination in—													
		11 days	14 days	18 days	22 days	25 days	28 days	32 days	35 days	39 days	42 days	46 days	49 days	53 days	56 days	60 days
Irish Cobbler:	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Dry	24	8	20	36	48	72	100									
Wet	24	8	20	48	64	76	84	92	100							
Dry	48	4	32	72	88	100										
Wet	48	8	44	92	92	100										
Check							8	12	20	26	56	92	100			
Triumph:																
Dry	24	16	48	88	92	100										
Wet	24	16	44	64	80	88	100									
Dry	48	16	64	80	92	100										
Wet	48	12	52	76	92	100										
Check						4	4	4	4	8	12	24	48	76	92	96

A third treatment was made 1 week later, October 5, in which two concentrations of ethylene chlorhydrin, 0.5 and 1 cc per liter of air space, were used with a uniform exposure of 24 hours for all lots. In comparison with the lots treated September 28 the results, as presented in table 13, indicate a slower rate of germination in all but two treated lots and a somewhat quicker germination of the untreated lots. The lot showing quickest response was from the 1-cc-moistened tubers of the Irish Cobbler variety.

TABLE 13.—*Ethylene chlorhydrin gas treatment with 0.5 and 1 cc per liter of air space for 24 hours, using in each test 20 tubers of the Irish Cobbler and Triumph varieties*

[Potatoes harvested Sept. 12 and treated Oct. 5, 1931]

Variety and condition of whole tubers	Strength of treatment	Rate of germination in—												
		11 days	15 days	18 days	21 days	25 days	28 days	32 days	35 days	39 days	42 days	46 days	49 days	53 days
Irish Cobbler:	*Cc*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Dry	0.5	5	20	30	50	80	90	100						
Wet	1	10	20	30	60	80	90	90	100					
Dry	.5	10	15	55	65	90	90	100						
Wet	1	60	70	90	100									
Check								10	35	65	80	100		
Triumph:														
Dry	.5	25	35	50	65	80	90	90	95	95	100			
Wet	1	15	50	70	90	90	90	95	95	100				
Dry	.5	15	30	60	80	90	95	95	100					
Wet	1	25	50	70	85	90	90	90	95	100				
Check								5	10	35	70	90	90	95

The fourth set of treatments of the Irish Cobbler and the Triumph also included the Katahdin variety. The treatments differed from those made the week previous in that sacks and baskets were substituted for the wet and dry comparisons.

An examination of the data presented in table 14 would seem to indicate a slight advantage in favor of the basket container in the Triumph and Katahdin, while the response from the Irish Cobbler sacked tubers was slightly though not markedly quicker than those in baskets. It is not felt, however, that the difference was sufficiently marked to be convincing.

TABLE 14.—*Ethylene chlorhydrin gas treatment with 0.5 cc per liter of air space for 24 hours, using in each test 20 tubers of the Irish Cobbler, Triumph, and Katahdin varieties of potatoes*

[The first two varieties were harvested Sept. 12 and the last Oct. 1; treated Oct. 12-13, 1931]

Variety and container of wet whole tubers	Rate of germination in—										
	10 days	13 days	17 days	20 days	24 days	27 days	31 days	33 days	37 days	40 days	44 days
Irish Cobbler:	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Sack			5	10	35	95	100				
Basket		5	15	25	30	75	100				
Check							35	70	85	95	
Triumph:											
Sack	5	15	45	55	75	90	90	100			
Basket		15	50	75	100						
Check								25	55	60	80
Katahdin:											
Sack	10	15	35	40	40	100					
Basket	35	70	85	85	100						
Check						30	45	55	60	75	100

The most outstanding feature of this test is to be noted in the response of the Katahdin tubers to the treatment. Taking into consideration the fact that they were not harvested until October 1 and

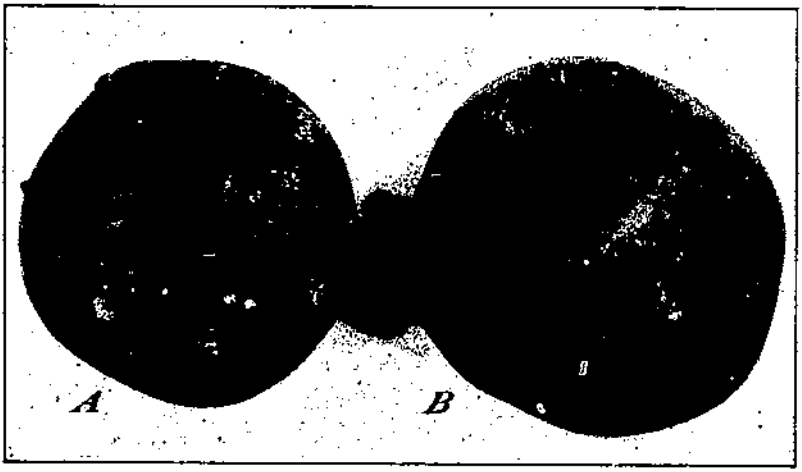

FIGURE 7.—Katahdin potatoes: *A*, Treated Oct. 12, 1931, in a 0.5-cc-per-liter concentration of ethylene-chlorhydrin gas for 24 hours; *B*, tuber untreated. Photographed 13 days after treatment.

were treated 11 days afterward it is rather remarkable that the basket-treated lot showed a 35-percent germination in 10 days from time of removal from chamber October 12, 85 percent in 17 days, and 100 percent in 24 days, at which time the untreated or check lot did not show germination. From the standpoint of a short rest period it is equally significant that the untreated Katahdin tubers, although harvested 19 days later than the Irish Cobbler and the Triumph, nevertheless showed a prompter germination (fig. 7).

A fifth treatment of Irish Cobbler and Katahdin potatoes with ethylene-chlorhydrin gas was made October 19 to 21, using concentrations of 0.5 and 1 cc per liter of air space. The 0.5-cc treatment was

continued for 48 hours and the 1-cc treatment for 24 hours. All lots were in burlap sacks. The treated Katahdin tubers gave 100 percent germination with both treatments in 21 days, while the treated Irish Cobbler tubers germinated 100 percent in 25 and 28 days, respectively.

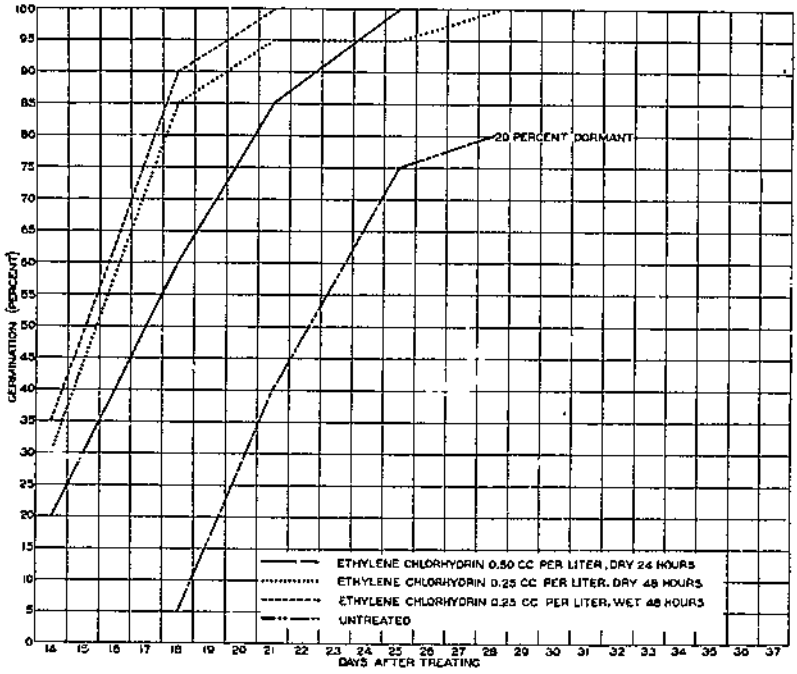

FIGURE 8.—Rate of germination of treated and untreated Katahdin tubers harvested October 1 and treated October 26–27, 1931, with ethylene chlorhydrin. Tubers placed in a 70° F. room immediately after treatment.

Both lots of untreated tubers gave complete germination in 39 days. Detailed data are presented in table 15.

TABLE 15.—*Ethylene chlorhydrin gas treatment with 0.5 and 1 cc per liter of air space for 24 hours, using in each test 20 tubers of the Irish Cobbler and Katahdin varieties*

[Potatoes harvested Sept. 12 and Oct. 1, respectively; treated Oct. 19–21, 1931]

Variety and condition of whole tubers	Treatment		Rate of germination in—								
	Strength	Period	11 days	14 days	18 days	21 days	25 days	28 days	32 days	35 days	39 days
	Cc	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Irish Cobbler:											
Dry, in sacks	0.5	48	15	40	50	80	95	100			
Do	1.0	24	5	45	65	95	100				
Check							10	25	70	80	100
Katahdin:											
Dry, in sacks	.5	48	30	70	80	100					
Do	1.0	24	25	80	90	100					
Check							30	50	80	90	100

A sixth treatment of Irish Cobbler and Katahdin tubers was made on October 26, 1931, in which the ethylene-chlorhydrin concentrations were at the rate of 0.25 and 0.5 cc per liter of air space. Dry and wet

tubers of each variety were subjected to a 48-hour exposure to the 0.25-cc concentration, while similar lots were given a 24-hour treatment in the 0.5-cc-per-liter concentration. In the case of both the Irish Cobbler and Katahdin there was no material difference in the rate of germination of the dry and wet tubers in the weaker concentration. A slight retardation was noted in the case of the 0.5-percent treatment. The relatively prompt germination of the untreated tubers in both varieties affords conclusive evidence of the passage of the rest period. As usual the Katahdin showed a prompter germination than the Irish Cobbler (table 16 and fig. 8).

TABLE 16.—*Ethylene chlorhydrin gas treatment with 0.25 and 0.5 cc per liter of air space for 24 hours, using in each test 20 tubers of the Irish Cobbler and Katahdin varieties*

[Potatoes harvested Sept. 12 and Oct. 1, and treated Oct. 26, 1931]

Variety and condition of whole tubers	Treatment		Rate of germination in—					
	Strength	Period	14 days	18 days	21 days	25 days	28 days	32 days
Irish Cobbler:	*Cc*	*Hours*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Dry	0.25	48	15	75	90	100	.....	.....
Wet	.25	48	25	60	90	95	100	.....
Dry	.5	24	20	32	65	90	100	.....
Check	.....	.....	.....	.....	5	50	65	100
Katahdin:								
Dry	.25	48	30	85	95	95	100	.....
Wet	.25	48	35	90	100	.....	.....	.....
Dry	.5	24	20	60	85	100	.....	.....
Check	.....	.....	.....	5	40	75	80	100

A summary of the data for the Irish Cobbler variety, presented in tables 11 to 16, inclusive, shows that the interval between treatment and a 90-percent or even higher germination was 21 days, with an actual average germination of 92.3 percent, as compared with 0.83 percent from the untreated seed.

A similar comparison of the data for the Triumph variety, given in tables 11 to 14, shows a 21¼-day time interval between treatment and an average germination of 94.5 percent, as against no germination from the untreated seed.

The three Katahdin treatments of October 12–13, 19–21, and 26 indicate a 20-day time interval between treatment and a 93.3-percent germination, while the untreated lots gave only 1.67 percent tuber germination.

It should be stated that these data are not based on the average of each period of treatment but on the average of the shortest time intervals in each of the several treatments.

A final treatment of Katahdin potatoes was given November 2 to 4, in which a somewhat extensive comparison was made of the relative efficacy of 0.25- and 0.5-cc concentrations of ethylene chlorhydrin gas treatments for 24 and 48 hours. Both baskets and burlap sacks were used. The promptest germination was obtained from the 0.5-cc treatment, in which tubers in baskets gave 100 percent germination in 18 days. Four lots, two of each concentration, including one of the 24-hour treatment, gave perfect germination in 21 days, while the remaining three lots of treated seed gave complete germination in 25 days. Of greatest interest

is the fact that the untreated lot showed 85 percent germination in the 25-day period (table 17 and fig. 9).

This would seem to indicate that the Katahdin potato has a comparatively short rest period, as only 33 days elapsed between the date of harvesting the seed and its treatment. If to this is added the 25-day interval between treatment and an 85-percent germination of the sets, there is a total of 58 days. It should be

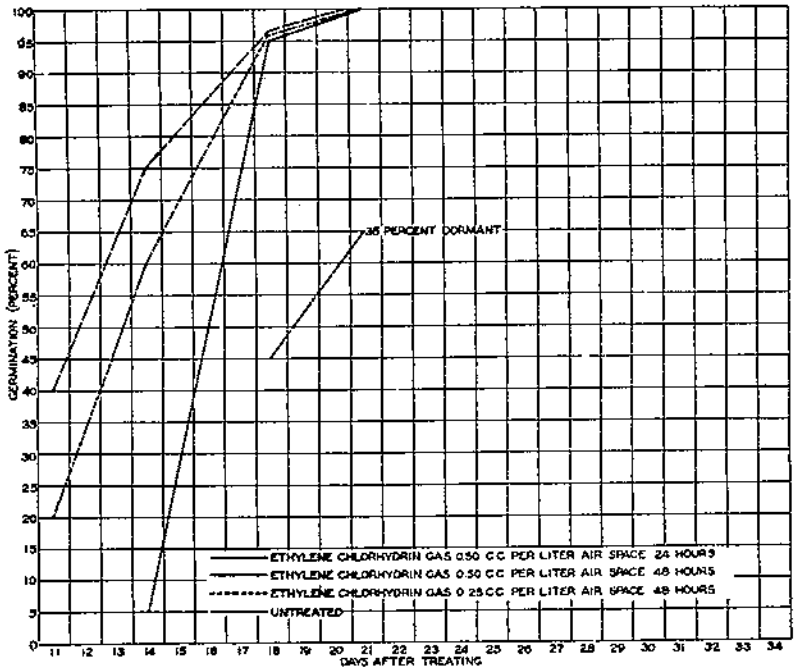

FIGURE 9.—Rate of germination of treated and untreated Katahdin tubers harvested October 1 and treated November 2-3, 1931, with ethylene chlorhydrin. Tubers placed in a 70° F. room immediately after treatment.

stated that the plants when harvested might be regarded as having just reached maturity, so no allowance need be made for their having passed into the rest period before harvesting.

TABLE 17.—*Ethylene-chlorhydrin gas treatment with 0.25- and 0.5-cc per liter of air space for 24 hours, using in each test 20 tubers of the Katahdin variety*

[Potatoes harvested Oct. 1 and treated Nov. 2, 1931]

Variety and container of dry whole tubers	Treatment		Rate of germination in—				
	Strength	Period	11 days	14 days	18 days	21 days	25 days
Katahdin:	*Cc*	*Hours*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Sack	0.25	24	5	25	65	90	100
Basket	.25	24	5	10	60	90	100
Do	.5	24	------	5	95	100	------
Do	.5	24	5	45	55	95	100
Do	.25	48	20	60	95	100	------
Do	.25	48	10	40	70	100	------
Do	.5	48	40	75	95	100	------
Do	.5	48	30	70	100	------	------
Check	------	------	------	------	45	65	85

The question might well be raised in connection with this particular instance as to the value of such late treatments when only a short time interval is gained. This question would also apply in the case of several other varieties herein reported. The writers offer the following reasons: (1) It seemed desirable to study the reaction of the several varieties recorded, in order to ascertain the relative response to certain chemical treatments designed to shorten the rest period. (2) The length of the rest period was deemed worthy of further study; hence, in some instances, as in the case of the Katahdin, it was possible to demonstrate its comparatively short rest period. The writers do not advocate subjecting seed potatoes to chemical treatment for shortening the rest period except when necessary to plant them within a relatively short interval after harvesting. In such cases it is believed that sufficient evidence is now available to assure its successful use commercially.

SUMMARY AND CONCLUSIONS

The presentation of a paper by Johannsen in 1893 furnished the first evidence of the stimulative effect of anaesthetics on resting plants. It was found that when plants were subjected to ether or chloroform fumes in a tight container for 48 hours or more a marked growth stimulus was produced as an afterresult.

Johannsen's discovery found its greatest immediate application in shortening the rest period of hard-wooded flowering plants.

In recent years other chemical substances have been substituted for ether and chloroform which are equally if not more effective and are more convenient to apply.

Of approximately 224 substances tested for their action in shortening the rest period of potatoes, Denny found that ethylene chlorhydrin and the thiocyanates of sodium and potassium were, on the whole, the most effective.

Chemical treatments of potato sets to shorten the rest period were undertaken during the fall and winter of 1928–29, with the idea of studying its commercial possibilities.

Of the 27 varieties treated, the Prolific showed the quickest response, being closely followed by four others.

The most pronounced results were obtained from sets treated with a 6-percent solution of ethylene chlorhydrin and in 1- and 2-percent solutions of sodium thiocyanate and afterward held in tight containers from 6 to 48 hours.

Plants produced from sets dipped in a 3-percent sodium-thiocyanate solution and held in closed containers for periods of 6, 12, 18, and 24 hours showed considerable foliage injury. This treatment also delayed germination.

A marked difference was noted in the response from sets of Dakota Red treated on November 12, 1928, as compared with that from sets treated December 20, 1928. In the first instance there was no response in 28 days, while in the later treatment 100-percent germination was obtained in 27 days, the difference in response being due to a lessened depth of the rest period.

In the 1929–30 experiment special consideration was given to a study of the relative merits of the ethylene-chlorhydrin and sodium-

thiocyanate treatments. The experiments were conducted with 23 varieties, and, as in the previous seasons, a considerable variation in response was noted. Prolific showed the quickest response from the ethylene-chlorhydrin treatment. Early Rose, Noroton Beauty, Prolific, Burbank, and Keeper appeared to have the shortest rest period.

The most successful results based on relative germination of treated and untreated sets were obtained from White Ohio, Beauty of Hebron, Queen-of-the-Valley, Early Manistee, and the White-Eyed Peachblow.

The 1931 treatments of whole tubers with ethylene-chlorhydrin gas for 24 and 48 hours rather conclusively demonstrated the efficacy of this gas in shortening the rest period.

Sufficient evidence was obtained to justify the statement that certain varieties are more easily stimulated into growth than others. Prolific and Katahdin are apparently sensitive to chemical treatments and also seem to have a short rest period.

The behavior of the untreated potatoes in the summer and fall experiments of 1931 affords a fairly accurate index of the normal rest period of the potato when held at temperatures favorable to germination. It also affords a ready means of studying this factor in seedling progenies.

On the whole, the results obtained during studies covering four seasons indicated a prompter germination response from the ethylene-chlorhydrin treatments than from sodium thiocyanate, but as a rule the latter soon caught up and frequently surpassed the former. This is rather clearly indicated in figures 2 to 9.

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TABLE 4.—*Varietal responses of potato seed pieces treated with chemicals to shorten the rest period in 1929*

Variety and chemical used	Date treated	Date planted	Concentration	Time of treatment	Rate of germination in—																												
					12 days	13 days	14 days	15 days	16 days	17 days	18 days	19 days	20 days	21 days	22 days	23 days	24 days	25 days	26 days	27 days	28 days	29 days	30 days	31 days	32 days	33 days	34 days	35 days	36 days	37 days	38 days	39 days	40 days
			Pct.	Hours	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Early Ohio:																																	
Ethylene chlorhydrin	Oct. 29	Oct. 30	6	24											63				73					90						97			
Sodium thiocyanate	do	do	1	1											33				57					93						100			
Do	do	do	1.5	1											13				37					73						97			
Do	do	do	2	1											10				27					47						93			
Do	do	do	1	1.5											27				43					87						100			
Do	do	do	1.5	1.5											7				37					60						93			
Do	do	do	2	1.5															13					30						41			
Untreated		do																	3					17						50			
Queen-of-the-Valley:																																	
Ethylene chlorhydrin	Oct. 29	do	6	24								17			63				90					90						97			
Sodium thiocyanate	do	do	1	1								3			60				97					100									
Do	do	do	1.5	1								7			70				80					97									
Do	do	do	2	1								7			63				83					97						100			
Do	do	do	1	1.5								7			63				87					93						100			
Do	do	do	1.5	1.5											23				63					90						100			
Do	do	do	2	1.5											10				57					73						100			
Untreated		do																															
White Ohio:																																	
Ethylene chlorhydrin	Oct. 30	Oct. 31	6	24							23					90				97													
Sodium thiocyanate	do	do	1	1							3					30				70						100							
Do	do	do	1.5	1												17				53						97			100				
Do	do	do	2	1												7				33						77			57				
Do	do	do	1	1.5												23				87						100							
Do	do	do	1.5	1.5												7				63						90			97				
Do	do	do	2	1.5																30						67			70				
Untreated		do																															
Keeper:																																	
Ethylene chlorhydrin	Oct. 30	do	6	24					68					88																			
Sodium thiocyanate	do	do	1	1					32					84				92					92			100							
Do	do	do	1.5	1					16					56				88					96			100							
Do	do	do	2	1					4					52				84					88										
Do	do	do	1	1.5					28					84				92					92			96							
Do	do	do	1.5	1.5					24					81				92					100										
Do	do	do	2	1.5										36				64					92										
Untreated		do							4					20				20					44			52							
Adirondack:[1]																																	
Ethylene chlorhydrin	Oct. 31	Nov. 1	6	24													4					8			8								
Sodium thiocyanate	do	do	1	1									64				80					88			88								
Do	do	do	1.5	1									32				64					84			88								
Do	do	do	2	1									16				56					76			84								
Do	do	do	1	1.5									16				44					76			76								
Do	do	do	1.5	1.5									8				20					40			52								
Do	do	do	2	1.5				4					20				24					56			60								
Untreated		do						12					40				68					80			88								
Early Rose:[1]																																	
Ethylene chlorhydrin	Oct. 31	do	6	24				13					27				30					33			33								
Sodium thiocyanate	do	do	1	1				7					37				77					80			93								
Do	do	do	1.5	1				3					20				17					63			80								
Do	do	do	2	1													10					63			77								
Do	do	do	1	1.5									43				60					73			83								
Do	do	do	1.5	1.5									20				57					70			90								
Do	do	do	2	1.5									7				30					43			63								
Untreated		do											10				40					77			87								
American Giant:[1]																																	
Ethylene chlorhydrin	Nov. 1	Nov. 2	6	24												4					4			4									
Sodium thiocyanate	do	do	1	1			8					48				80					88			92									
Do	do	do	1.5	1								24				40					52			80									
Do	do	do	2	1												32					60			88									
Do	do	do	1	1.5								26				60					84			92									
Do	do	do	1.5	1.5								4				40					48			60									
Do	do	do	2	1.5																	12			56									
Untreated		do										12				28					48			72									
Green Mountain:[1]																																	
Ethylene chlorhydrin	Nov. 1	do	6	24																													
Sodium thiocyanate	do	do	1	1								4				17					70			80						83			
Do	do	do	1.5	1												30					43			77						87			
Do	do	do	2	1												10					40			57						83			
Do	do	do	1	1.5								7				50					80			93						100			
Do	do	do	1.5	1.5								7				7					33			57						93			
Do	do	do	2	1.5												13					20			43						80			
Untreated		do																						7						10			
Charles Downing:																																	
Ethylene chlorhydrin	Nov. 4	Nov. 5	6	24					16				36					60						96			96					96	
Sodium thiocyanate	do	do	1	1					12				32					60						96			100						
Do	do	do	1.5	1					1				4					32						72			80					84	
Do	do	do	2	1									4					20						88			100						
Do	do	do	1	1.5					4				40					56						100									
Do	do	do	1.5	1.5									12					28						72			80					92	
Do	do	do	2	1.5									4					16						40			56					64	
Untreated		do											4					8						8			12					28	
Dakota Red:																																	
Ethylene chlorhydrin	Nov. 4	do	6	24					7				17					60						90			100						
Sodium thiocyanate	do	do	1	1									33					67						97			100						
Do	do	do	1.5	1									7					47						80			90					90	
Do	do	do	2	1														7						63			70					80	
Do	do	do	1	1.5									7					30						77			90					90	
Do	do	do	1.5	1.5									3					63						77			83					87	
Do	do	do	2	1.5														7						73			83					87	
Untreated		do																						7			7					10	
White Star:																																	
Ethylene chlorhydrin	Nov. 4	do	6	24					23				10					70						90			90					91	
Sodium thiocyanate	do	do	1	1					10				43					67						83			90					62	
Do	do	do	1.5	1									23					37						60			70					90	
Do	do	do	2	1									3					7						37			43					67	
Do	do	do	1	1.5					16				10					63						50			97					97	
Do	do	do	1.5	1.5									7					17						57			87					87	
Do	do	do	2	1.5									3					17						57			73					87	
Untreated		do											10					17						37			43					57	
McCormick:																																	
Ethylene chlorhydrin	Nov. 5	Nov. 6	6	24						10				43						90						93					93		
Sodium thiocyanate	do	do	1	1						3				17						17						57					73		
Do	do	do	1.5	1																3						23					63		
Do	do	do	2	1																						13					27		
Do	do	do	1	1.5										13						40						77					83		
Do	do	do	1.5	1.5																17						43					63		
Do	do	do	2	1.5																						13					23		
Untreated		do																		17						37					10		
Scotch Rose:																																	
Ethylene chlorhydrin	Nov. 5	do	6	24								40					60						83			93					100		

TABLE 4.—*Varietal responses of potato seed pieces treated with chemicals to shorten the rest period in 1929*

d	Concentration	Time of treatment	Rate of germination in—																																						Decayed seed
			12 days	13 days	14 days	15 days	16 days	17 days	18 days	19 days	20 days	21 days	22 days	23 days	24 days	25 days	26 days	27 days	28 days	29 days	30 days	31 days	32 days	33 days	34 days	35 days	36 days	37 days	38 days	39 days	40 days	41 days	42 days	43 days	44 days	45 days	46 days	47 days	48 days	49 days	50 days	
	Pct.	*Hours*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
0	6	24											63				73					99						97														3
	1	1											33				57					93						100														--
	1.5	1											13				37					73						97														3
	2	1											10				27					47						93														7
	1	1.5											27				43					87						100														
	1.5	1.5											7				37					60						93														7
	2	1.5															13					30						44														33
																	3					17						50														7
	6	24								17			63				90					90						97														3
	1	1								3			60				97					100																				
	1.5	1								7			70				80					97																				3
	2	1								7			63				83					97						100														
	1	1.5								7			63				87					93						100														
	1.5	1.5											23				63					90						100														
	2	1.5											10				57					73						100														
																																										7
31	6	24							23					90				97																								3
	1	1							3					30				70						100																		--
	1.5	1												17				53						97			100															
	2	1												7				33						77			87															13
	1	1.5												23				87						100																		
	1.5	1.5												7				63						90			97															3
	2	1.5																30						67			70															30
																																			3							0
	6	24					68					88																														12
	1	1					32					84				92					92			100																		....
	1.5	1					16					56				88					96			100																		
	2	1					4					52				84					88																					12
	1	1.5					28					84				92					92			96																		4
	1.5	1.5					24					84				92					100																					
	2	1.5										30				64					92																					8
							4					20				20					44			52																		0
1	6	24													4					8			8																			92
	1	1									64				80					88			88																			12
	1.5	1									32				64					64			88																			12
	2	1									16				56					76			84																			16
	1	1.5									16				44					76			76																			24
	1.5	1.5									8				20					10			52																			48
	2	1.5				4					20				24					56			60																			40
						12					40				68					80			88																			4
	6	24				13					27				30					33			33																			67
	1	1				7					37				77					80			93																			[illegible]
	1.5	1				3					20				47					63			80																			20
	2	1													10					63			77																			23
	1	1.5									43				60					73			53																			17
	1.5	1.5									20				57					70			90																			10
	2	1.5									7				30					43			63																			47
											10				40					77			87																			6
2	6	24												4					4			4																				96
	1	1			8					48				80					88			92																				8
	1.5	1								21				40					52			80																				20
	2	1												32					60			88																				12
	1	1.5								20				60					84			92																				8
	1.5	1.5								4				40					48			60																				40
	2	1.5																	12			56																				44
										12				28					48			72																				8
	6	24																																								109
	1	1								4				47					70			80						83					90									10
	1.5	1												30					43			77						87					90									7
	2	1												10					10			57						83					90									10
	1	1.5								7				50					80			93						100														
	1.5	1.5								7				7					33			57						93					100									
	2	1.5												13					20			43						80					83									17
																						7						10					17									0
5	6	24					16				36					60						96			96					96												4
	1	1					12				32					60						96			100																	
	1.5	1					1				4					32						72			80					84												16
	2	1									4					20						88			100																	
	1	1.5					1				40					56						100																				
	1.5	1.5									12					28						72			80					92												4
	2	1.5									4					16						40			56					64												72
											4					8						[illegible]			12					28												8
	6	24					7				17					60						90			100																	
	1	1									33					67						97			100																	
	1.5	1									7					47						80			80					90												30
	2	1														7						63			70					80												20
	1	1.5									7					30						77			90					90												10
	1.5	1.5									3					43						77			84					87							90					10
	2	1.5														7						73			84					87							87					13
																						7			7					30							30					3
	6	24					23				40					70						90			90					93												[illegible]
	1	1					10				43					67						83			90					97												[illegible]
	1.5	1									23					37						60			70					90												10
	2	1									3					7						37			43					67							73					23
	1	1.5					10				10					63						90			97					87												6
	1.5	1.5									7					17						57			87					87												13
	2	1.5									3					17						57			73					87							90					10
											10					17						37			13					57							70					0
6	6	24						10				13						90						33					63							93					97	[illegible]
	1	1						3				17						47						57					73							83					90	10
	1.5	1																3						33					63							73					83	7
	2	1																						13					27							50					53	20
	1	1.5										13						40						77					83							90					93	7
	1.5	1.5																17						43					63							73					73	17
	2	1.5																						13					23							17					60	20
																		17						37					30							60					87	27

Sodium thiocyanate	do	do	1	1						3			17					17					57				73		
Do	do	do	1.5	1														3					33				63		
Do	do	do	2	1																			13				27		
Do	do	do	1	1.5									13					40					77				53		
Do	do	do	1.5	1.5														17					43				63		
Do	do	do	2	1.5																			13				23		
Untreated		do																17					37				40		
Scotch Rose:																													
Ethylene chlorhydrin	Nov. 5	do	6	24								40				60					83		93				100		
Sodium thiocyanate	do	do	1	1								7				13					97		97				97		
Do	do	do	1.5	1								7				17					60		77				97		
Do	do	do	2	1								3				7					20		43				90		
Do	do	do	1	1.5								3				7					70		93				97		
Do	do	do	1.5	1.5																	47		57				97		
Do	do	do	2	1.5																	13		20				67		
Untreated		do																			7		20				27		
Burbank (Low-top):																													
Ethylene chlorhydrin	Nov. 6	Nov. 7	6	24			27				63				80		87			90		93							
Sodium thiocyanate	do	do	1	1			33				57				73		80			83		83							
Do	do	do	1.5	1			3				33				63		73			80		80							
Do	do	do	2	1			3				10				23		53			60		70							
Do	do	do	1	1.5			10				73				97		100												
Do	do	do	1.5	1.5							23				63		80			83									
Do	do	do	2	1.5							3				20		53			60		77							
Untreated		do									3				7		30			47		53							
Northern Spy:																													
Ethylene chlorhydrin	Nov. 6	do	6	24			10				43				53					62						62			
Sodium thiocyanate	do	do	1	1			7				47				63					77						83			
Do	do	do	1.5	1							17				40					70						93			
Do	do	do	2	1											13					40						87			
Do	do	do	1	1.5			3				20				57					70						77			
Do	do	do	1.5	1.5			3				7				23					67						87			
Do	do	do	2	1.5											7					27						63			
Untreated		do																		10						17			
Early St. George:																													
Ethylene chlorhydrin	Nov. 7	Nov. 8	6	24		33				83				90					90						93				
Sodium thiocyanate	do	do	1	1		7				20				37					93						97				97
Do	do	do	1.5	1										7					70						93				97
Do	do	do	2	1															23						73				80
Do	do	do	1	1.5						17				30					80						97				
Do	do	do	1.5	1.5										3					60						93				100
Do	do	do	2	1.5										7					80						97				97
Untreated		do																	10						67				77
Early Manistee:																													
Ethylene chlorhydrin	Nov. 7	do	6	24		30				83				93					97						97				100
Sodium thiocyanate	do	do	1	1		3				20				43					63						80				80
Do	do	do	1.5	1		3				3				23					37						67				77
Do	do	do	2	1										10					37						70				87
Do	do	do	1	1.5						17				53					93						93				97
Do	do	do	1.5	1.5															40						70				83
Do	do	do	2	1.5										3					13						63				83
Untreated		do												3					17						43				80
White Rose:																													
Ethylene chlorhydrin	Nov. 8	Nov. 9	6	24					20				33					57			83			90				93	
Sodium thiocyanate	do	do	1	1					7				20					53			80			97				97	
Do	do	do	1.5	1														30			67			90				97	
Do	do	do	2	1									7					27			50			77				87	
Do	do	do	1	1.5									27					60			80			87				93	
Do	do	do	1.5	1.5									7					30			57			70				80	
Do	do	do	2	1.5									3					20			50			80				87	
Untreated		do																3			23			80				87	
Prolific:																													
Ethylene chlorhydrin	Nov. 8	do	6	24	30				93							93					93			93				93	
Sodium thiocyanate	do	do	1	1	7				37							83					97								
Do	do	do	1.5	1	13				17							57					90			97				97	
Do	do	do	2	1					3							27					70			87				87	
Do	do	do	1	1.5	17				40							80					97								
Do	do	do	1.5	1.5												50					83			93					
Do	do	do	2	1.5												10					43			70				77	
Untreated		do			7				13							47					70			90				97	
Noroton Beauty:																													
Ethylene chlorhydrin	Nov. 11	Nov. 12	6	24							3		23			67		87				90							
Sodium thiocyanate	do	do	1	1									17			47		77				90			93				
Do	do	do	1.5	1												3		17				90			100				
Do	do	do	2	1														20				73			93				
Do	do	do	1	1.5									10			33		63				97			97			100	
Do	do	do	1.5	1.5												13		57				93			97			100	
Do	do	do	2	1.5														23				87			97			100	
Untreated		do											3			13		37				77			87			90	
White-Eyed Pearlblow:																													
Ethylene chlorhydrin	Nov. 11	do	6	24		7		57			73		100																
Sodium thiocyanate	do	do	1	1		10		47			50		80					90				97						100	
Do	do	do	1.5	1		7		17			20		63					83				100							
Do	do	do	2	1				13			20		43					77				97							
Do	do	do	1	1.5				20			40		70					100											
Do	do	do	1.5	1.5							7		17					87				90						93	
Do	do	do	2	1.5									27					80				97							
Untreated		do											7					13				33						50	
Beauty of Hebron:																													
Ethylene chlorhydrin	Nov. 11	do	6	24		17					43		77			93		100											
Sodium thiocyanate	do	do	1	1		3					3		30			30		80				90			97				
Do	do	do	1.5	1									3			3		37				83			97				
Do	do	do	2	1									7			7		20				53			87				
Do	do	do	1	1.5							3		13			33		73				93			100				
Do	do	do	1.5	1.5												10		37				80			80				
Do	do	do	2	1.5														10				57			67				
Untreated		do																3				30			77				
Early Rose:[2]																													
Ethylene chlorhydrin	Nov. 12	Nov. 13	6	24	7					53					80		90												
Sodium thiocyanate	do	do	1	1	7					17					50		67							84			83		
Do	do	do	1.5	1						7					27		53							77					
Do	do	do	2	1						0					33		50							60			67		
Do	do	do	1	1.5						13					57		77							83					
Do	do	do	1.5	1.5						3					33		73							73					
Do	do	do	2	1.5											13		37							67					
Untreated		do													53		80							93					

[1] High temperature throughout period of treatment.
[2] Second lot of Early Rose.

ment.

END