THE EFFECT OF TUBERTONE AND THIOUREA TREATMENTS ON THE DEVELOPMENT OF THREE POTATO VARIETIES

A Thesis

Submitted to

the Faculty of Graduate Studies and Research

The University of Manitoba

In Partial Fulfillment

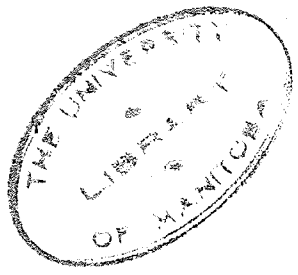
of the Requirements for the Degree of

Master of Science

by

Nicholas Sandar

May 1954



THE EFFECT OF TUBERTONE AND THIOUREA TREATMENT ON THE DEVELOPMENT OF THREE POTATO VARIETIES

N. SANDAR

ABSTRACT

A study of the effects of Tubertone and thiourea treatments of seed pieces of the Warba, Irish Cobbler and Pontiac varieties was conducted during 1951 and 1952.

The results with Tubertone indicate that under certain conditions treatment may prove valuable for increasing marketable yields of the Warba and Pontiac varieties without increasing the tuber size. Treatment of the Irish Cobbler variety resulted in reduced plant vigour and reduced yields. The Pontiac variety produced an increase in the number of tubers per hill but only when planted early. Tubertone treatment had no effect on either hollow heart or storage quality.

Thiourea treatment increased the tuber set and effectively reduced the tuber size, but resulted in reduced marketable and total yields with the Warba and Irish Cobbler varieties. The average size of Pontiac tubers was reduced without a reduction in yield. Although the number of stems per plant was increased to a lesser degree. This increase was mostly small tubers less than two inches in diameter. Thiourea treatment had no effect on hollow heart but caused early sprouting in storage.

ACKNOWLEDGEMENTS

The writer wishes to express his sincere appreciation to Prof.E.T.Andersen, Associate Professor of Plant Science, under whose direction these experiments were carried out, for his continued advice and encouragement. Appreciation is extended to Prof.S.B.Helgeson for his advice related to statistical analysis. The experiments were carried out in conjunction with the Potato Breeding program, and funds supplied by the Manitoba Department of Agriculture for the operation of this program are gratefully acknowledged. Thanks are due to A.Chernick for valuable assistance in photography.

TABLE OF CONTENTS

LIST OF GRAPHS

LIST OF TABLES

INTRODUCTION

The potato crop comprises an important part of the Agricultural economy of Manitoba with an estimated value of about $4,000,000 annually. Yearly acreage has been estimated to be as high as 34,000 acres but this has decreased somewhat in recent years. This decrease can be largely attributed to improved production practices and resultant increased yields per acre. Marketable yields, so essential to the grower in order to realise satisfactory returns per acre, have not always increased proportionately with the increase in the total yield. This has been especially true on the rich soils of the Red River Valley, where in seasons of ample moisture conditions, the problems of oversize tubers often becomes serious. Hollow heart, usually associated with large tubers, has in some years reached such serious proportions that marketing of certain varieties has been very difficult.

The problem of oversize tubers can be readily realized when the size requirements of table stocks and seed potatoes are considered. The maximum diameter of tubers allowed for a Canada No. 1 grade table potato is 4 inches, however large tubers close to this limit are not generally desired by consumers. In the same way, oversize tubers in seed stocks represent a loss to the seed grower since they must be graded out. Size limits for seed potatoes are 3 ounces to 12 ounces for Grade A, and $1\frac{1}{2}$ - 3 ounces for Grade B. Small tubers (less than 2 inches in diameter) in table stock have little or no market value, but Grade B seed potatoes are desirable for planting whole, especially where soil borne diseases are a problem.

Thus any practice that would increase the percentage of marketable tubers for table stock or seed purposes would be of considerable economic importance to the potato growers of Manitoba. Treatment of potato seed with thiourea has been found to produce more stems per hill (7), and may answer the problem of producing more tubers which are smaller and more uniform in size. Tubertone, a plant hormone preparation containing thiourea, naphthylacetamide, 2 - methyl naphthylene acetic acid, 2 - methyl naphthylacetamide in a talc carrier, is reported to produce some multiple sprouting and to encourage plant vigour and yield (1).

The study reported here was undertaken to evaluate the effects of seed tuber treatments with Tubertone and thiourea on tuber set, tuber size, yields and certain quality factors using three varieties, Warba, Irish Cobbler and Pontiac.

REVIEW OF LITERATURE

Several investigators have studied the influence of size and character of seed, and spacing upon the resultant potato crop. Chucka et al (4) and Smith et al (14) both state that as the size of the seed pieces is increased the resulting plants are more vigourous, have more stems and more tubers per hill, and usually produce a larger total yield. They further state that locality, fertility level, season, variety and spacing affected the yield of marketable tubers. Close spacing resulted in a smaller average size of tuber. On high yielding fields, even with close spacing, they found as much as 10 per cent of the tubers by weight to be over 12 ounces. The work of Chucka et al (4) indicated that the use of larger seed pieces resulted in increased yields which were associated with greater number of tubers per hill.

Smith (13) studied the effects of seed piece size and spacing under Manitoba conditions. The greatest total and marketable yields per acre resulted with the use of the highest rate of planting, i.e. 4 ounce seed pieces spaced at 9 inches. The percentage of marketable tubers (3 - 12 oz) in weight decreased as the seed piece size increased or as the spacing diminished, as a large percentage were below 3 ounces. When seed pieces were small or spacing wide there was a larger percentage of oversize tubers. Although the highest rate of planting gave the largest marketable yield per acre, he found that the best economic return per acre resulted from the use of 2 ounce seed pieces with 12 - 15" spacing.

Werner (20) at Nebraska studied factors influencing hollow heart in the Russet Rural potato. He found that the prevalence of hollow heart increased with the size of the tubers produced. Hollow heart was correlated with the small number of stems per plant, with the highest incidence of hollow heart produced by three stem plants. Generally, only one hollow tuber was produced per plant, but a few plants produced as many as four hollow tubers. Control of hollow heart was obtained to an appreciable extent by planting large seed pieces, especially whole tubers. There was a definite correlation between the size of tubers and the size of the hollow within the tuber.

Studies of the effect of thiourea treatment of potato seed have been carried out by numerous workers. Denny (7) in 1926 found that thiourea (NH_2CSNH_2) inhibits the growth of the apical eye in whole potato tubers or the apical bud within the eye. By soaking potatoes for one hour in a 3 per cent thiourea solution he obtained multiple sprouts with the Bliss Triumph, Irish Cobbler, McCormick and Rural New Yorker varieties. With Irish Cobbler, which exhibits strong apical dominance, he obtained a reversal from apical to basal dominance.

Crocker (5) summarized the work on dormancy of potatoes at the Boyce Thompson Institute for Plant Research. Ethylene chlorohydrin and thiocyanates were effective in causing prompt growth of buds with no modifications. Thiourea, although only a fair bud forcer, resulted in growth modifications. Where normally only one bud in an eye would grow, it was found that thiourea treatment broke up this growth relationship by

forcing all bud primordea in an eye to grow. In the same way the growth relationship between eyes in a seed piece was modified by forcing all eyes in a seed piece to grow. Crocker also states that thiourea treatment evidently interferes with the oxidation system of the tuber, for cut surfaces of treated seed pieces remained white for a long time after planting, whereas untreated ones turned brown readily. The relationship of oxygen to dormancy of potato tubers was studied by Thornton (19). He found that dormancy exists in freshly harvested tubers because the bud tissues are exposed to free oxygen and continues until the periderm or skin thickens to such an extent as to retard oxygen penetration. When potatoes were stored at low oxygen concentrations, apical dominace was broken and a definite increase in the number of sprouts resulted.

Werner (21) treated cut seed pieces of the Russet Rural potato with a 1 per cent thiourea solution and obtained an increase in the number of stems and tubers per hill, with a decrease in the size of tubers and the amount of hollow heart. Effects were in direct proportion to the length of the treatment and the concentration of the solution. A very large increase in the seed piece size was necessary to equal the effect obtained with thiourea treatment. Yields were slightly reduced but compared favourably with the checks when the sound No. 1 tubers with no hollow heart plus the small tubers suitable for seed were considered.

Woodbury (22), Eastman et al (8) (9), Steinbauer (15), and Terman et al (16) all report an increase in the number of stems per plant and

and the number of tubers per hill as a result of thiourea treatment. Woodbury (22) also reports reduction in tuber size when Russet Burbank potatoes were treated with 4% thiourea solution. Eastman et al (9) report an increase in the yields of tubers $1\frac{1}{2}$ - $2\frac{1}{2}$ inches in diameter with a 1% thiourea soak and a 3% thiourea dip treatment. Murphy (12) obtained an increase of 1.45 tubers per hill with a 3% thiourea dip treatment. He states that there was an increase in the proportion of the smaller sized tubers with the three varieties he tested. Steinbauer (15) found that low grade thiourea and the pure product showed equal effectiveness in inducing multiple sprouts. Terman et al (16), state that although the number of stems per plant was greatly increased, the number of tubers per hill was increased to a smaller degree.

Terman et al (16) (17), and Murphy (12) report a significant decrease in total yield as a result of thiourea treatment even though the number of tubers per hill was increased.

Terman et al (17) compared affectiveness of close spacing and thiourea treatment in controlling tuber size. Decreasing the spacing from 9 to 5 inches was much more effective in increasing the number of tubers than was thiourea treatment. He found thiourea treatment ineffective for controlling oversize in the Kennebec variety.

Casseres et al (3) treated the Katahdin, Kennebec and Sebago varieties by soaking seed for one hour in a 1% thiourea solution and by dipping seed in a 3% solution. The 1% soak treatment significantly reduced the stands and reduced the number of jumbos (over 12 ounces) by

66% as compared with the checks. The 3% dip treatment did not affect stands, and reduced jumbos by 92% as compared with the checks. Both treatments reduced the average size of Katahdin and Sebago tubers but increased the size of Kennebac tubers. The differences between the average number of tubers set between varieties as a result of thiourea treatment were highly significant. A 3% thiourea dip plus water rinse treatment showed no beneficial effect on tuber set and yield, but did seem to stimulate plant development.

Little published information on the use of Tubertone in field applications is available. The manufacturing concern (1) summarized available information on Tubertone in its Technical Service Data Sheet issued in April of 1950. It is reported that an employee of the manufacturer had attempted to prevent potatoes from sprouting by treatment with the methyl ester of naphthalenacetic acid, one of the hormones found in Tubertone. When the Katahdin variety was treated at low concentrations, there was an actual increase in sprouting. Rootone, a chemical agent containing two of the hormones found in Tubertone, is reported to have given increased potato yields in tests carried out in Oklahoma and Pennsylvania. As a result, Tubertone was formulated in 1944 and tried in field tests in Maine, U.S.A and Sweden. It was found that weak sprouting varieties like Katahdin seemed to give the most striking results. Generally, treated plants were slower in starting growth, but they caught up and were harvested at the same time as untreated plots. Various figures given claim an increase up to 38.6% in marketable tubers.

Hardenburg (10) studied the effect of growth promoting substances on potatoes. He reports that Rootone which contains two of the hormones found in Tubertone, delayed emergence, reduced plant stands, and appeared toxic to root growth of potatoes. However, Rootone treated seed produced more vigorous growth at the end of the season and the increase in yield of U.S. No. I tubers was highly significant.

Murphy (12) obtained no increase in the number of stems per plant from Tubertone treatment, no delay or reduction of stands and no increase in smaller sized tubers. He obtained an increase in the tuber set per hill at the recommended rate of $\frac{1}{2}$ lbs of Tubertone per bushel, and an increase in the average total yield. This increase was in the larger oversize group which is undesirable for table stock or seed purposes.

MATERIAL AND METHODS

A study of the effects of Tubertone and thiourea treatments of potato seed pieces was carried out at the University of Manitoba during 1951 and 1952. A split plot design experiment of four replicates was used, with the following variables listed in order of sub-division:

A.	Dates of planting:-	1. early 2. late
B.	Varieties:-	1. Warba 2. Irish Cobbler 3. Pontiac
C.	Dates of top killing:-	1. early 2. late 3. harvest date with no killing
D.	Treatments:-	1. Tubertone 2. thiourea 3. check with no treatment

The same plan and scheme of randomization was used in both years. Each treatment plot consisted of one row of 20 hills. Guard hills were used only at the outside ends of each long row (8 plots) and along the sides of the whole experiment. With 3 foot spacing between rows and 15 inches in the row, the experiment covered in area of 87 feet x 100 feet.

The experiments were located at the University of Manitoba, Fort Garry, where the soil is a silt clayloam. Summer-fallowed land was used and no fertilizers were applied.

Three varieties Warba, Irish Cobbler and Pontiac were chosen as representative of early, midseason and late maturing varieties respectively. All three varieties are extensively grown in Manitoba, with oversize and hollow-heart tubers serious problems in some years. The seed used in 1951

was the first generation from Certified Seed and had been stored in the University of Manitoba root cellar. At the time of cutting for early planting, the dormancy was well broken. For late planting, two weeks later, the sprouts were long and had to be broken off. In 1952 Certified Seed was used which was in a good state of dormancy, both for early and late planting.

The tubers were cut the day before planting, as for any ordinary field planting. Consequently the seed pieces were not of uniform size and number of eyes. The average size was approximately two ounces. Cut seed pieces were divided at random into three lots. One lot of each variety was treated with Tubertone, the other with thiourea and the third lot was left untreated.

Tubertone was applied at the rate of $\frac{1}{2}$ pound per bushel. Each lot of cut seed pieces to be treated was spread on a floor covered with heavy paper. These were dusted with Tubertone using several layers of cheesecloth as a dusting bag. The pile was stirred several times and thorough coverage was readily attained. The treated seed pieces were then bagged and made ready for planting the following day.

A 3% thiourea solution was prepared by adding 0.3 pounds of thiourea to one Imperial gallon (10 lbs) of water. Cut seed pieces of each variety were placed separately in mesh bags and immersed in the solution for 25 - 30 seconds. Treated lots were allowed to dry and were later bagged, ready for planting.

Planting in 1951 was done by hand with the use of a hoe. In 1952,

a garden tractor was used to open furrows which gave a more uniform depth of planting as compared to the hand method in 1951. A marked line was stretched tight along the row to get uniform spacing. In both years early planting was done on May 16th and 17th, and the late planting two weeks later on June 1st and 2nd.

Stand counts and counts on the number of stems in each plot of the first two replicates were made in late June in each of the two years. Observations on the relative vigour of the treated and untreated plots were also made.

For top killing, the tops were cut off at ground level by using a hand sickle. The early top killing date was on August 24th in both years. The late top killing dates were on September 8th in 1951 and September 4th in 1952. Check plots were not top killed.

Harvesting in 1951 was delayed unavoidably due to extremely wet conditions. Plots, top killed at the early and late dates, were harvested during the four days, September 17th - 20th. Plots that were not top killed were harvested on October 12th - 13th. In 1952 the early and late top killed plots were harvested on September 14th and 15th, while plots not top killed were harvested on September 27th.

Records on number and weights of marketable (Canada No.1) and total tubers were taken during harvest. A composite sample of marketable tubers for each treatment was retained, made up of approximately 10 pounds from each replicate. In November of each year the specific gravity of each sample was determined. In 1951, this was done by weighing a sample of approximately 25 lbs of tubers in air and then in water and calculating the specific gravity. In 1952, the Bewell potato

hydrometer (2) was used for specific gravity determinations.

Ten of the largest tubers from each treatment sample were cut and checked for hollow heart in each of the two years.

Samples of the 1951 crop were kept in storage all winter. In April observations on sprout growth were made. A 40 plant sample of each treatment was grown to check on possible residual effects of treatment.

The total and marketable yields per plot were converted to bushels per acre yields. The number of stems, the total number and the number of marketable tubers per plot were all reduced to an individual hill basis. The average size of marketable and all tubers was obtained by dividing the weight in ounces per plot by the number of tubers per plot. The analysis of variance for split plot experiments as outlined by Cochran and Cox (6), and Hayes and Immer (11) was applied to each set of the above data.

EXPERIMENTAL RESULTS AND DISCUSSION

Growing Conditions

Growing conditions varied considerably in each of the two years during which the experiment was carried out. Percipitation data for the two years is given in the Appendix, Table I. The early part of the 1951 season was relatively dry, accompanied by high winds which caused considerable soil drifting. About 2 inches of soil was deposited over a part of one replicate which delayed emergence but the final growth was not seriously affected. Extremely wet weather in August favored the development of late blight in some plots. The soil was quite saturated so that even small amounts of rain during September delayed harvesting operations. In 1952, abnormally high rainfall during the latter part of June resulted in some flooding of two low areas of the experimental plots. Conditions during August and September were relatively dry and resulted in a smaller crop than in 1951.

Effect of Treatment on Emergence, Vigour and Plant Stand

Emergence was retarded by 3 to 5 days as a result of thiourea treatment. With Tubertone treatment, there were no adverse effects and emergence was similar to the untreated plots.

Observations on vigour and growth of the treatment plots were made during the season. Thiourea treatment resulted in noticeably reduced and bushier growth in early stages, but the difference in vigour was no longer apparent at 8 weeks after emergence. Tubertone treated plots of the Warba and Pontiac varieties, planted at the early date, were as vigorous and in many cases more vigorous than untreated plots. Tubertone

treatment, with the Irish Cobbler variety, resulted in a slight but definite reduction in plant vigour. With late planting, all three varieties showed reduced vigour as a result of Tubertone treatment, with a more pronounced effect in 1951 than in 1952. Treatment effects on the plot vigour of the Irish Cobbler variety as they appeared on July 9th, 1952 is shown in Plates I and II on page 15. Plate I and II show the response with early and late planting respectively.

Table I shows the effect of treatment on plant stand in 1951 and 1952. The stand was over 99% with all treatments in 1952. In 1951, possibly due to dry soil conditions in the spring, seed piece rotting reduced stands in all plots. Tubertone treated plots had the best stand indicating that it may be beneficial in preventing seed piece rotting.

TABLE I - PLANT STAND AS AFFECTED BY TREATMENT IN 1951 AND 1952
(PERCENTAGE OF PERFECT STANDS)

	Check	Tubertone	Thiourea
1951	89.2	95.4	89.4
1952	99.8	99.7	99.4

Effect of Treatment on the Number of Stems per Plant

In the analysis of variance (Table II) applied to the number of stems per plant, there were six replicates for each treatment, since stem counts were made prior to top killing and only with the first two replicates. The F values in this table show that the number of stems per

PLATE I - Variety Irish Cobbler - early planting date. Treatments left to right - Tubertone, thiourea, check. Note reduced vigour and bushy appearance of thiourea treated plot. Photographed July 9th, 1952 by A. Chernick.

PLATE II - Variety Irish Cobbler - late planting date. Treatments left to right - check, thiourea, Tubertone. Note reduced vigour in thiourea treated plot. Photographed July 9th, 1952 by A. Chernick.

TABLE II - ANALYSIS OF VARIANCE OF THE NUMBER OF STEMS PER PLANT SHOWING THE YEAR, DATE OF PLANTING, TREATMENT AND VARIOUS INTERACTION EFFECTS

Variation due to	D.F.	Mean Square	F.
Years	1	3.2807	2.73
Replicates	5	.2804	-
Error (a)	5	1.2013	-
Block Total	11		
Dates of Planting	1	4.1204	10.72 * *
Y X D	1	2.1460	5.58 *
Error (b)	10	.3842	-
Date Total	23		
Varieties	2	4.5488	18.75 * *
Y X V	2	2.2767	9.38 * *
D X V	2	.5806	2.39
Y X D X V	2	1.6638	6.86 * *
Error (c)	40	.2426	-
Variety Total	71		
Treatments	2	83.4888	387.42 * *
Y X T	2	11.0779	51.40 * *
D X T	2	2.1059	9.77 * *
V X T	4	2.3165	10.75 * *
Y X D X T	2	6.0046	27.87 * *
Y X V X T	4	.5548	2.57 *
D X V X T	4	.5438	2.52 *
Y X D X V X T	4	1.0559	4.90 * *
Error (d)	120	.2155	-
Grand Total	215		

* F. value significant at 5% point

** F. value significant at 1% point

plant was significantly affected by dates of planting and by varieties. The effect of dates of planting was not the same in both years as shown in Table III. In 1951, there was no difference in the number of stems per plant with early and late planting. In 1952, late planting resulted in a much higher number of stems per plant than early planting. The varieties Irish Cobbler, Pontiac and Warba produced an average of 3.73, 3.43 and 3.23 stems per plant respectively, (Table IV). This relationship was not the same in both years and at both dates of planting as shown by the significant years by dates of planting by varieties interaction.

Treatment effects on the number of stems per plant showed significant interactions with years, dates of planting and varieties both as first and second order interactions. However, the variance due to treatments significantly exceeded all but the interactions of years by treatments and years by dates of planting by treatments. It can therefore be concluded that treatment effects on the number of stems per plant were quite constant.

The effect of treatment on the number of stems per plant in each of two years and at two dates of planting is shown in Table III. The average number of stems per plant was significantly increased as a result of thiourea treatment with an increase of 1.72 stems per plant as compared to the checks with no treatment. Thiourea treatment resulted in significant increases in the number of stems per plant in both years and at both dates of planting, with by far the largest increase with late planting in 1952. Although Tubertone treatment resulted in a significant decrease in the average number of stems per plant, the effects were not

the same in both years and at both dates of planting. This decrease was significant only in 1952 at the late planting date.

TABLE III - NUMBER OF STEMS PER PLANT AS AFFECTED BY TREATMENT IN 1951 AND 1952 AND AT THE EARLY AND LATE PLANTING DATES

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
1951 Early Planting	3.55	2.95	3.12	4.57	0.37
Late Planting	3.62	3.50	3.17	4.18	0.37
1951 Average	3.59	3.23	3.15	4.38	0.22
1952 Early Planting	3.10	2.53	2.43	4.34	0.37
Late Planting	3.57	2.89	2.14	5.69	0.37
1952 Average	3.34	2.72	2.28	5.01	0.22
Early Planting average		2.74	2.77	4.45	0.22
Late Planting average		3.20	2.66	4.94	0.22
Treatment average		2.97	2.72	4.69	0.15

Table IV shows the varietal responses to treatment. With thiourea treatment, Pontiac showed the largest significant increase in the number of stems per plant with an increase of 2.4 stems. With Tubertone treatment, only the Warba and Irish Cobbler varieties showed a significant reduction in the number of stems per plant.

The stem growth of the Irish Cobbler variety with no treatment in 1952 is shown in Plate III (page 20). This can be compared with the typical stem growth as a result of thiourea treatment in the same year as shown in Plate IV (page 20).

The effect of thiourea treatment on the number of stems per plant

TABLE IV - NUMBER OF STEMS PER PLANT OF THE WARBA, IRISH COBBLER AND PONTIAC VARIETIES AS AFFECTED BY TREATMENT

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
Warba	3.23	2.86	2.51	4.31	0.27
Irish Cobbler	3.73	3.38	3.09	4.71	0.27
Pontiac	3.43	2.67	2.55	5.07	0.27

was quite consistent with significant increases in both years, at both dates of planting and with all three varieties. Results with Tubertone treatment were not conclusive. The number of stems of the Warba and Irish Cobbler varieties were significantly reduced but only with late planting in 1952.

Effect of Treatment on the Yield, Number and Average Size of Marketable Tubers.

The results of the analysis of variance as applied to each set of data for the yield, number and average size of marketable tubers appear in Table V. It can be seen from the data that the yield, number and average size of marketable tubers have in most cases been affected by variables other than the main treatment effects studied. Thus in each of the following subsections, in order to present a clear picture, a brief discussion of the effects of years, dates of planting, varieties and dates of top killing, precedes the main discussion of treatment and various interaction effects.

A. Marketable Yields

Examination of significant F values in Table V shows that marketable

PLATE III - Variety Irish Cobbler. Note typical stem growth with no treatment. Photographed July 21st, 1952 by A.Chernick.

PLATE IV - Variety Irish Cobbler. Note typical stem growth with thiourea treatment. Photographed July 21st, 1952, by A.Chernick.

TABLE V - ANALYSIS OF VARIANCE OF THE YIELD, NUMBER AND AVERAGE SIZE OF MARKETABLE TUBERS, SHOWING THE YEAR, DATE OF PLANTING, VARIETY, TOP KILLING, TREATMENT AND INTERACTION EFFECTS

Variation due to	D.F.	Mark. Yield F.	Number of Mark. Tubers per hill F.	Ave. size of Mark. Tubers F.
Years	1	413.69 * *	9.52	196.63 * *
Reps	3	17.33 *	2.05	9.64
Error (a)	3	-	-	-
Block Total	7			
Dates of Planting	1	56.12 * *	118.60 * *	-
Y X D	1	2.01	2.68	1.17
Error (b)	6	-	-	-
Date Total	15			
Varieties	2	20.30 * *	61.88 * *	14.39 * *
Y X V	2	18.20 * *	1.34	13.08 * *
D X V	2	8.69 * *	6.47 * *	13.31 * *
Y X D X V	2	-	6.73 * *	15.03 * *
Error (c)	24	-	-	-
Variety Total	47			
Killing Date	2	115.08 * *	14.66 * *	55.55 * *
Y X K	2	27.14 * *	6.44 * *	3.25 *
D X K	2	2.35	-	7.29 * *
V X K	4	12.53 * *	3.62 *	2.25
Y X D X K	2	-	2.69	2.56
Y X V X K	4	8.06 * *	2.12	1.02
D X V X K	4	1.72	-	-
Y X D X V X K	4	1.24	2.34	1.05
Error (d)	72	-	-	-
Killing Total	143			
Treatments	2	43.95 * *	1.91	613.99 * *
Y X T	2	11.70 * *	8.18 * *	1.52
D X T	2	3.55 *	8.27 * *	1.16
V X T	4	3.96 *	3.96 * *	1.95
K X T	4	-	1.55	-
Y X D X T	2	3.03	1.55	12.27 * *
Y X V X T	4	6.22 * *	1.42	1.13
D X V X T	4	19.30	15.27 * *	2.35
Y X K X T	4	-	-	-
D X K X T	4	-	-	1.59
V X K X T	8	1.32	1.39	-
Y X D X V X T	4	19.24 * *	15.89 * *	4.38 * *
Y X D X K X T	4	-	-	1.74
Y X V X K X T	8	-	1.29	-
D X V X K X T	8	-	1.14	1.05
Y X D X V X K X T	8)	-	-	-
Error (e)	216)			
Grand Total	431			

* F. value significant at 5% point. * * F. value significant at 1% point.

yields were affected by years, dates of planting, varieties, dates of top killing, and treatments. The marketable yield was significantly higher in 1951 than in 1952 as seen in Table VI. Date of planting also affected the marketable yield with the highest yield produced at the early planting date. The Warba variety produced the highest yield, followed in order by Irish Cobbler and Pontiac (Table VII). However, there was a significant interaction of varieties with years and dates of planting. Irish Cobbler outyielded Pontiac in 1951 but the converse was true in 1952. Similarly Pontiac outyielded Irish Cobbler when planted early but the converse was true when planted late.

Marketable yield was significantly affected by the date of top killing. Plots top killed at the early date produced lower marketable yields than those top killed at the late date or not top killed, with greater differences in 1951 than in 1952. Varieties responded to top killing according to their length of growing season as demonstrated in Figure I. The Warba and Irish Cobbler varieties are relative early of maturity and showed no further increase in marketable yield after the late top killing date, but Pontiac, a late variety, produced a further significant increase in plots that were not top killed.

The effect of treatment on the average marketable yield and on the yield in 1951 and 1952 is shown in Table VI. Thiourea treatment significantly reduced the marketable yield in both years by an average reduction of 37.4 bushels per acre. The significant increase in the average marketable yield as a result of Tubertone treatment was due to the large increase of 44.4 bushels in 1951, for no increase occurred in 1952.

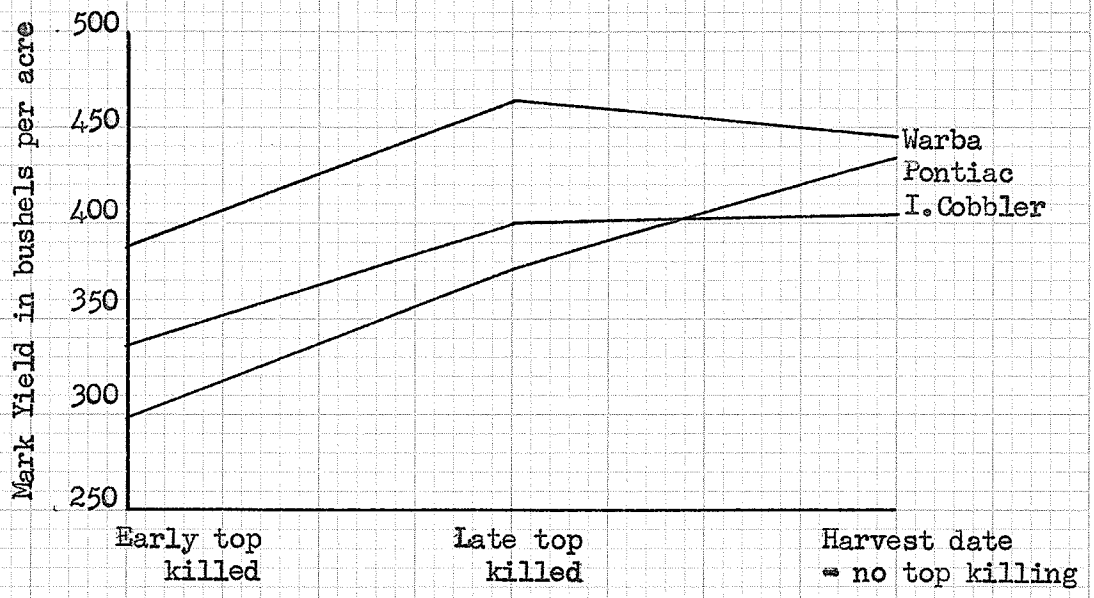


FIGURE I - THE MARKETABLE YIELD OF THREE VARIETIES AS AFFECTED BY DATES OF TOP KILLING

TABLE VI - MARKETABLE YIELD IN BUSHELS PER ACRE AS AFFECTED BY TREATMENT IN 1951 AND 1952 AND AT THE EARLY AND LATE PLANTING DATES

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
1951 Early Planting	544.3	525.0	596.9	511.4	24.1
Late Planting	403.9	405.6	432.4	373.6	24.1
1951 Average	474.1	465.3	514.7	442.5	17.4
1952 Early Planting	361.0	372.7	367.5	342.7	24.1
Late Planting	265.3	294.3	279.7	222.0	24.1
1952 Average	313.1	333.5	323.6	282.4	17.4
Early Planting ave.	452.7	449.2	482.1	426.9	17.4
Late Planting ave.	334.6	349.4	356.2	298.1	17.4
Treatment average		399.5	419.2	362.1	11.6

The reduction in yield as a result of thiourea treatment was constant at both dates of planting but with Tubertone treatment the increase in marketable yield occurred only with early planting (Table VI). The F value for the interaction of treatments with dates of top killing was not significant, showing that the effects of treatments were constant at all three dates of top killing. Varietal responses to treatment are shown in Table VII. The Warba and Irish Cobbler varieties showed a significant reduction in marketable yield as a result of thiourea treatment. With Tubertone treatment, there was a significant increase in marketable yield with the Warba and Pontiac varieties.

TABLE VII - MARKETABLE YIELDS IN BUSHELS PER ACRE OF THE WARBA, IRISH COBBLER AND PONTIAC VARIETIES AS AFFECTED BY TREATMENT

	Check	Tubertone	Thiourea	L.S.D.-5%
Warba	437.5	466.6	391.1	21.3
Irish Cobbler	399.8	396.9	342.7	21.3
Pontiac	361.1	394.0	352.0	21.3

The reduction in the marketable yield as a result of thiourea treatment was consistent in both years, at both dates of planting and at all three dates of top killing. There was a significant reduction in the marketable yield with the Warba and Irish Cobbler varieties. The fact that there was no significant reduction in the average marketable yield of the Pontiac variety was probably due to the actual increase that occurred with early planting in 1951. The effects of Tubertone treatment on marketable yields were inconclusive. The Warba and Pontiac varieties planted early in 1951 produced a significant increase in yield as a result of Tubertone treatments, whereas the effects were negative with late planting or in 1952.

B. Number of Marketable Tubers per Hill

The variance (F.Values) under the column for number of marketable tubers per hill in Table V show that the number remained quite constant in both years, but was affected by dates of planting, varieties and dates of top killing. Planting at the early date resulted in more marketable tubers per hill than planting at the late date (Table IX). The Warba

variety produced the highest number of tubers per hill, followed in order by Irish Cobbler and Pontiac (Table X). In 1951, Warba planted at the early date resulted in a much higher number of marketable tubers per hill than Warba planted at the late date. Early top killing resulted in a significantly lower number of marketable tubers per hill, as compared to either the late date of top killing or no top killing. This difference was greater in 1951 than in 1952 and most pronounced with the Pontiac variety.

The effect of treatments on the average number of marketable tubers per hill was not significant, however first order interactions of treatments with years, dates of planting and varieties were highly significant. There was no interaction of treatments with dates of top killing. Table VIII shows the effect of treatment on the number of marketable tubers in 1951 and 1952. Both thiourea and Tubertone treatments resulted in significant increases in the number of marketable tubers per hill in 1951 only. No significant differences occurred with either treatment in 1952.

TABLE VIII - NUMBER OF MARKETABLE TUBERS PER HILL AS AFFECTED BY TREATMENT IN 1951 AND 1952

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
1951	6.44	5.52	6.03	5.77	0.25
1952	4.98	5.09	4.91	4.95	0.25
Treatment average		5.31	5.47	5.36	0.17

The effect of treatment on the number of marketable tubers with early and late planting is shown in Table IX. With early planting, both thiourea and Tubertone treatments resulted in significant increases in the number of marketable tubers per hill. With late planting, thiourea treatment resulted in a significant reduction but Tubertone treatment had no effect on the number of marketable tubers per hill.

TABLE IX - NUMBER OF MARKETABLE TUBERS PER HILL AS AFFECTED BY TREATMENT AT TWO PLANTING DATES

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
Early planting	6.18	5.93	6.29	6.33	.25
Late planting	4.58	4.69	4.66	4.39	.25

Table X shows the effect of treatment on the number of marketable tubers per hill with three varieties. With the Pontiac variety, both thiourea and Tubertone treatments resulted in a significant increase in the number of marketable tubers per hill. The numbers of the other two varieties were not affected by treatment.

It is difficult to draw any general conclusions as to the effect of treatment on the number of marketable tubers per hill, due to the conflicting interactions. With thiourea treatment, late planting significantly reduced the number of marketable tubers per hill. However, a significant increase in the number occurred with the Pontiac variety planted early in 1951. With early planting in 1952 the numbers were not

affected. With Tubertone treatment, late planting did not affect the number of marketable tubers. As with thiourea treatment, there was a significant increase only with the Pontiac variety planted early in 1951.

TABLE X - NUMBER OF MARKETABLE TUBERS PER HILL OF THE WARBA, IRISH COBBLER AND PONTIAC VARIETIES AS AFFECTED BY TREATMENT

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
Warba	6.17	6.10	6.32	5.98	0.30
Irish Cobbler	5.29	5.40	5.32	5.17	0.30
Pontiac	4.71	4.42	4.78	4.93	0.30

C. Average Size of Marketable Tubers.

The average size of marketable tubers was significantly affected by years (Table V) with larger tubers produced in 1951 than in 1952. The variety Pontiac produced the largest average size of marketable tubers followed in order by Warba and Irish Cobbler (Table XI). The varieties did not react the same way in the two years or at the two dates of planting. In 1951 the Warba variety when planted late produced the largest tubers.

The date of top killing resulted in highly significant differences in the average size of marketable tubers. Tubers were smallest in plots that were not top killed at the early date and largest in plots that were not top killed. In 1951, the increase in tuber size was significantly greater in the periods following early and late top killing than in the

same periods in 1952. The effect of dates of top killing on the average size of the three varieties is demonstrated in Figure II, with only the late maturing Pontiac variety showing much increase in average size after the late top killing date. Interpretation of significant interactions of dates of top killing with dates of planting (Table V) shows that with late planting there was a large increase in the average size of marketable tubers after the late top killing date, but a very small increase in this period with early planting.

The variance due to treatment (Table V) significantly exceeded that of all interactions, and it can therefore be concluded that treatment effects on the average size of marketable tubers were quite constant. Table XI shows the effect of treatment on the average size of marketable tubers with three varieties. Tubertone treatment had no effect on the size, but thiourea treatment significantly reduced the average size of marketable tubers of all three varieties with an average reduction of 0.73 ounces.

TABLE XI - AVERAGE SIZE IN OUNCES OF MARKETABLE TUBERS OF THE WARBA, IRISH COBBLER AND PONTIAC VARIETIES AS AFFECTED BY TREATMENT

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
Warba	5.90	6.11	6.08	5.51	0.25
Irish Cobbler	5.83	6.01	6.05	5.42	0.25
Pontiac	6.45	6.82	6.71	5.81	0.25
Treatment Average	-	6.31	6.28	5.58	0.25

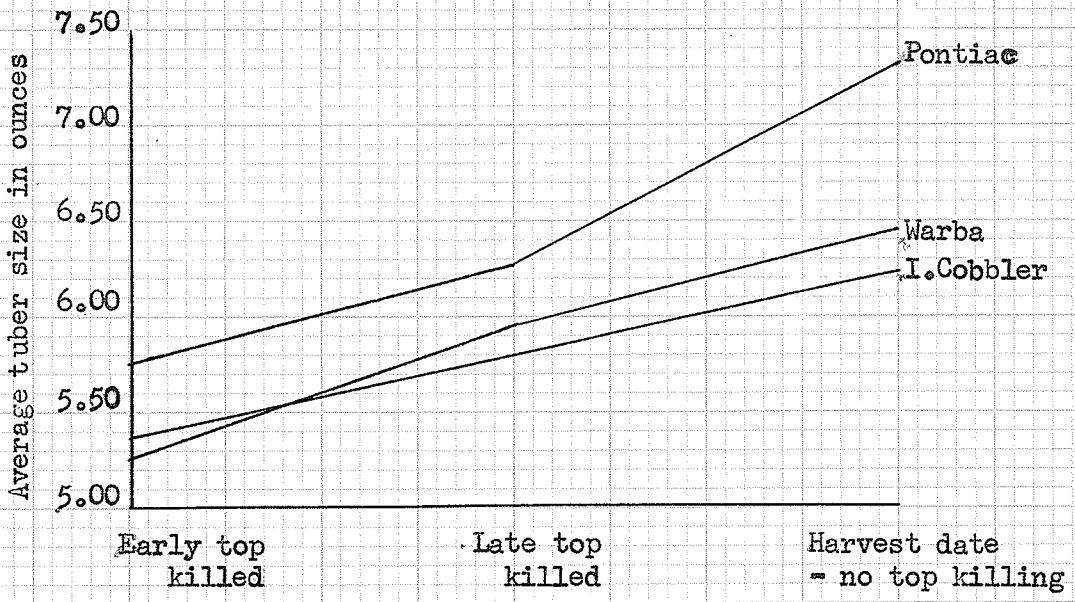


FIGURE II - THE AVERAGE SIZE OF MARKETABLE TUBERS OF THREE VARIETIES AS AFFECTED BY DATES OF TOP KILLING

TABLE XII - ANALYSIS OF VARIANCE OF THE YIELD, NUMBER AND AVERAGE SIZE OF ALL TUBERS SHOWING THE YEAR, DATE OF PLANTING, VARIETY, DATE OF TOP KILLING, TREATMENT AND INTERACTION EFFECTS

Variation due to	D.F.	Total Yield F.	Total Number of Tubers F.	Average Size of all Tubers F.
Years	1	74.88 * *	28.88 *	27.28 *
Reps	3	1.31	1.45	4.55
Error (a)	3	-	-	-
Block Total	7			
Dates of Planting	1	158.40 * *	92.20 * *	9.70 *
Y X D	1	7.76	1.16	-
Error (b)	6	-	-	-
Date Total	15			
Varieties	2	25.04 * *	51.52 * *	10.99 * *
Y X V	2	23.65 * *	16.44 * *	5.53 *
D X V	2	8.61 * *	8.13 * *	8.01 * *
Y X D X V	2	.10	3.21	4.74 *
Error (c)	24	-	-	-
Variety Total	47			
Killing Date	2	144.11 * *	14.54 * *	94.75 * *
Y X K	2	44.75 * *	18.74 * *	1.26
D X K	2	4.25 *	3.12 *	4.20 *
V X K	4	12.98 * *	2.96 *	5.41 * *
Y X D X K	2	.57	.36	1.92
Y X V X K	4	8.87 * *	1.47	1.20
D X V X K	4	2.86 *	3.28 *	1.31
Y X D X V X K	4	2.66 *	3.56 *	1.52
Error (d)	72			
Killing Total	143			
Treatments	2	27.99 * *	10.96 * *	77.56 * *
Y X T	2	12.49 * *	4.48 *	3.70 *
D X T	2	8.45 * *	10.44 * *	-
V X T	4	5.80 * *	3.94 * *	2.57 *
K X T	4	.57	.81	-
Y X D X T	2	3.11 *	8.99 * *	16.88 * *
Y X V X T	4	10.78 * *	3.62 * *	-
D X V X T	4	20.95 * *	10.78 * *	-
Y X K X T	4	.53	.58	-
D X K X T	4	.99	.43	1.28
V X K X T	8	1.19	1.48	-
Y X D X V X T	4	20.60 * *	8.20 * *	2.81 *
Y X D X K X T	4	.81	2.19	2.80 *
Y X V X K X T	8	.76	1.01	-
D X V X K X T	8	.52	.91	-
Y X D X V X K X T	8)			
Error (e)	216)			
Grand Total	431			

* F. value significant at 5% point * * F. value significant at 1% point

Effect of Treatment on the Yield, Number and Average Size of All Tubers

The results of the analysis of variance as applied to each set of data on the yield, number and average size of all tubers appear in Table XII. As in the previous section, a brief discussion of the effects of years, dates of planting, varieties and dates of top killing precedes the discussion of treatment and interaction effects.

A. Total Yield

Total yields were affected by years, dates of planting, varieties and dates of top killing as shown by significant F values in Table XII. The effects of these on total yield were very similar to their effects on marketable yields, which were discussed on pages 19 and 22.

The variance for treatment effects on the average total yield was highly significant (Table XII), however, interaction effects with years, dates of planting and varieties were also highly significant. There was no interaction of treatment effects with dates of top killing. Table XIII shows the effect of treatment on the average total yield and on the yield

TABLE XIII - TOTAL YIELD IN BUSHELS PER ACRE AS AFFECTED BY TREATMENT IN 1951 AND 1952

	Check	Tubertone	Thiourea	L.S.D.-5%
1951	556.1	604.0	540.1	17.4
1952	372.7	357.2	327.2	17.4
Treatment Average	464.6	480.6	433.6	12.6

in 1951 and 1952. Thiourea treatment reduced the average total yield, but this reduction was significant in 1952 only. Tubertone treatment resulted in a significant increase in the average total yield but this was due to the large increase of 47.9 bushels as a result of treatment in 1951, for no difference occurred in 1952.

The effect of treatment with early and late planting is shown in Table XIV. Thiourea treatment significantly reduced the total yield with late planting only. With Tubertone treatment, there was a significant increase in total yield with early planting only.

TABLE XIV - TOTAL YIELD IN BUSHELS PER ACRE AS AFFECTED BY TREATMENT AT TWO PLANTING DATES

	Check	Tubertone	Thiourea	L.S.D.-5%
Early Planting	512.1	548.9	506.3	17.4
Late Planting	416.2	412.4	361.1	17.4

The total yields of varieties were affected by treatment in the same way as were the marketable yields (Table VII). The total yield of Warba and Irish Cobbler was significantly reduced as a result of thiourea treatment, while the total yield of Warba and Pontiac was significantly increased with Tubertone treatment.

Treatment effects on the total yield were not conclusive. Late planting in general was not encouraging with either treatment, for reductions in total yield occurred as a result of thiourea treatment, while

Tubertone treatment did not produce any beneficial results. Thiourea treatment had no effect on the total yield of the Pontiac variety but reduced the total yield of the other two varieties. From these results, thiourea treatment can be expected to result in reduced total yields. Tubertone treatment did not reduce the total yield in any case but increased the total yield with the Warba and Pontiac Varieties. It can be expected that when Warba and Pontiac are planted early increased total yields would result with Tubertone treatment.

B. Total Number of Tubers per Hill

The total number of tubers per hill was significantly affected by years, dates of planting, varieties and dates of top killing (Table XII). The total number of tubers per hill was higher in 1951 than in 1952 (Table XV), although the number of marketable tubers per hill remained fairly constant. This indicates that in 1951 many tubers set late and failed to reach marketable size. Planting at the early date resulted in a higher total number of tubers per hill than planting at the late date, (Table XVI). The Warba variety produced the highest number of tubers followed in order by Irish Cobbler and Pontiac (Table XVII). There was no difference between the total number of tubers per hill of the Irish Cobbler and Pontiac varieties in 1952, but a large difference occurred in 1951. Significant interaction of varieties with dates of planting shows that late planting with Pontiac resulted in a significantly lower number of tubers when compared to early planting.

Early top killing resulted in the lowest average total number of tubers but there were significant interactions with years, dates of planting

and varieties. Early planting of the Warba variety in 1952 produced a higher number of tubers with early top killing than with either late top killing or no top killing. Early planted Irish Cobbler and Pontiac showed no difference in the total number of tubers harvested from plots that were top killed late or not top killed. However, when planted late, these varieties produced the highest number of tubers in plots that were not top killed.

The effect of treatment on the total number of tubers per hill was affected by years, dates of planting and varieties. There was no interaction of treatments with dates of top killing. Table XV shows the effect of treatment on the total number of tubers in 1951 and 1952. Thiourea treatment resulted in a significant increase in the total number of tubers per hill in both years with an average increase of 0.59 tubers. Tubertone treatment had no effect on the average number of tubers, however, it resulted in a significant decrease in 1952.

TABLE XV - TOTAL NUMBER OF TUBERS PER HILL AS AFFECTED BY TREATMENT IN 1951 AND 1952

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
1951	10.54	10.17	10.56	10.89	0.43
1952	7.87	7.88	7.39	8.34	0.43
Treatment Average		9.02	8.97	9.61	0.31

The effects of treatment at two dates of planting is shown in Table XVI. With early planting, thiourea treatment resulted in a large significant increase in the total number of tubers per hill, but there was no effect with late planting. Tubertone treatment resulted in a significant decrease with late planting only.

TABLE XVI - TOTAL NUMBER OF TUBERS PER HILL AS AFFECTED BY TREATMENT AT TWO DATES OF PLANTING

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
Early Planting	10.23	9.69	10.04	10.97	0.43
Late Planting	8.17	8.36	7.90	8.26	0.43

Treatment effects on the total number of tubers per hill with each variety is shown in Table XVII. Thiourea treatment resulted in a significant increase in the total number of tubers per hill with the Pontiac variety only, while Tubertone treatment significantly reduced the number of tubers of the Irish Cobbler variety.

TABLE XVII - TOTAL NUMBER OF TUBERS PER HILL AS AFFECTED BY TREATMENT AND VARIETIES

	Average	Check	Tubertone	Thiourea	L.S.D.-5%
Warba	10.35	10.27	10.18	10.61	0.53
Irish Cobbler	9.34	9.52	8.95	9.56	0.53
Pontiac	7.92	7.30	7.78	8.68	0.53

Further interpretation of interactions shows that the increases as a result of thiourea treatment in 1951 and with early planting were largely due to the response of Pontiac. With Tubertone treatment, the decreases in the total number of tubers that occurred in 1952 and with late planting were largely due to the response of the Irish Cobbler variety.

C. Average Size of All Tubers

Years, varieties and dates of top killing affected the average size of all tubers (Table XII). The results were very similar to those with the average size of marketable tubers (see pages 28 and 29). However, where dates of planting had no effect on the size of marketable tubers, it was found that the average size of all tubers was significantly larger with early planting than with late planting. The tuber size of the Pontiac variety increased significantly in the period following the late date of top killing, but there was little increase in this period in the average tuber size with the Warba and Irish Cobbler varieties.

The effect of treatment on the average size of tubers and on the size in 1951 and 1952 is shown in Table XVIII. Thiourea treatment resulted in a significant reduction in the tuber size in both years, with an average reduction of 0.61 ounces. With Tubertone treatment there was no effect on the average size of tubers.

Table XIX shows the effect of treatment on the average size of all tubers with three varieties. With Tubertone treatment there was no effect on the tuber size but thiourea treatment effectively reduced the average size of all tubers, with Pontiac showing the largest reduction.

TABLE XVIII - AVERAGE SIZE IN OUNCES OF ALL TUBERS AS AFFECTED BY TREATMENT IN 1951 AND 1952

	Check	Tubertone	Thiourea	L.S.D.-5%
1951	4.67	4.72	4.19	0.16
1952	4.00	4.07	3.25	0.16
Treatment Average	4.33	4.39	3.72	0.12

TABLE XIX - AVERAGE SIZE IN OUNCES OF ALL TUBERS OF THE WARBA, IRISH COBBLER AND PONTIAC VARIETIES AS AFFECTED BY TREATMENT

	Check	Tubertone	Thiourea	L.S.D.-5%
Warba	4.14	4.30	3.71	.20
Irish Cobbler	4.10	4.19	3.57	.20
Pontiac	4.76	4.69	3.89	.20

Effect of Treatment on Hollow Heart, Starch Content and Keeping Quality

A. Hollow Heart

It was found that hollow heart had occurred only in tubers of the 1951 crop. With 180 tubers cut in each variety, made up of 10 tubers from each composite treatment sample, there were 2 hollow tubers in each of the Warba and Pontiac varieties, and 25 hollow tubers in the Irish Cobbler variety. Of the two hollow tubers in the Warba variety, one occurred with Tubertone treatment with early planting, and the other with no treatment at the late date of planting. In the Pontiac variety both

hollow tubers occurred with no treatment at the early planting date. Of the 25 hollow tubers found in the Irish Cobbler variety, 3 were from plots planted early, of which 2 were from Tubertone treated plots and one from a thiourea treated plot. The other 22 hollow tubers occurred in samples from plots planted at the late date. There were 6 hollow tubers in check plots with no treatment, 8 in Tubertone treated plots and 8 in thiourea treated plots. Date of top killing appeared to have no effect on hollow heart for 7 hollow tubers occurred in early top killed plots, 7 in late top killed plots and 8 in check plots that were not top killed.

From the preceding observations it appears that neither treatment nor date of top killing had any effect on the amount of hollow heart tubers produced. The Irish Cobbler variety is well known for its susceptibility to hollow heart, while Warba and Pontiac are less susceptible. The fact that a high percentage of hollow tubers occurred when Irish Cobbler was planted late, indicates that certain growing conditions occurred at a critical stage of tuber development to initiate hollow heart. With early planting, apparently the tubers were not at this critical stage at the time that these conditions occurred and were therefore not affected.

B. Starch Content

The specific gravity determinations as made on treatment samples were converted to starch percentages by using a conversion scale supplied by the Central Experimental Farm, Canadian Department of Agriculture, Ottawa, Ontario. Determinations were made on composite treatment

samples with no replication. Statistical analysis, for which replication is necessary, was therefore not applied to the results. The average starch percentages of tubers from different treatments and varieties is shown in Table XX. There was no difference between the average starch content of the tubers from plots that were treated with thiourea and those from plots that were not treated. The average starch content of tubers from Tubertone treated plots was 0.11 per cent lower than that of tubers from untreated plots. This difference is small and could be the result of normal experimental differences. However, since there was a small decrease with all three varieties, it is felt that this decrease is probably not due to error, and could be expected to occur with Tubertone treatment.

TABLE XX - PER CENT STARCH OF THE WARBA, IRISH COBBLER AND PONTIAC VARIETIES AS AFFECTED BY TREATMENT (COMBINED DATA 1951-1952)

	Check	Tubertone	Thiourea
Warba	15.73	15.62	15.77
Irish Cobbler	16.28	16.11	16.08
Pontiac	14.65	14.58	14.77
Treatment Average	15.55	15.44	15.54

C. Keeping Quality

Storage samples of the 1951 crop were checked for condition in April of the following year. Tubers from thiourea treated plots of all three

varieties broke dormancy early, and the sprout growth was more advanced than that of tubers from untreated plots. Tubers from Tubertone treated plots stored as well as those from untreated plots, except with the Warba variety which showed indications of less sprouting. The effects of treatment on keeping quality were consistent at all three dates of top killing, ewen though the keeping quality was affected by the dates of top killing. Tuber samples from plots that were not top killed showed the least sprouting regardless of treatment, while those from early top killed plots showed the most sprouting.

Tuber samples were selected from storage samples and planted for observation. The number of stems, and the yield and number of tubers appeared normal in all treatment plots. This indicates that there was no apparent residual effects with either thiourea or Tubertone treatment.

SUMMARY AND CONCLUSIONS

A study of the effects of Tubertone and thiourea treatments of potato seed pieces was carried out during 1951 and 1952 at the University of Manitoba. The experiment was a split plot design, and the interaction effects of treatments with dates of planting, varieties and dates of top killing were studied.

Tubertone treatment consisted of dusting cut seed pieces at the rate of one-half pound to the bushel. Thiourea treatment consisted of dipping seed pieces for 25 - 30 seconds in a 3 per cent thiourea solution.

Tubertone treatment did not affect the rate of emergence, but resulted in a slight reduction in vigour particularly with the Irish Cobbler variety. The number of stems per plant of the Warba and Irish Cobbler varieties planted late were significantly reduced with Tubertone treatment. Treatment resulted in a significant increase in the marketable and total yields only in 1951 and only with early planted Warba and Pontiac. The effect of Tubertone treatment on the total number and marketable tubers per hill was inconclusive. Significant increases occurred in 1951, but the total number of tubers was reduced in 1952 with no effects on the number of marketable tubers. Increases in the number of tubers occurred only with the Pontiac variety planted early.

Tubertone treatment had no effect on the average size of marketable or all tubers or on the amount of hollow heart. There were indications that treatment would result in a reduction in per cent starch. Tubers from Tubertone treated plots stored as well as tubers from untreated plots with indications of better storage with the Warba variety. There were no

apparent residual effects of Tubertone treatment.

The results thus indicate that Tubertone under certain conditions may prove valuable for increasing marketable yields with the Warba and Pontiac varieties, without increasing the tuber size.

Thiourea treatment retarded emergence by 3 to 5 days. All treated plots were reduced in vigour in the early stages of growth, but little differences was noticeable eight weeks after emergence. Thiourea treatment resulted in a significant average increase of 1.72 stems per plant, with the greatest response shown by the Pontiac variety.

Thiourea treatment significantly reduced the marketable and total yield with the Warba and Irish Cobbler varieties, but no reduction occurred with the Pontiac variety. Reductions in yield were greater with late planting than with early planting.

The number of marketable tubers per hill of the Warba and Irish Cobbler varieties was not affected by thiourea treatment. However, the total number of tubers per hill of these varieties was significantly increased, showing that treatment resulted in a large increase of small tubers less than 2 inches in diameter. With the Pontiac variety there was a significant increase in the number of both marketable and total tubers per hill as a result of thiourea treatment.

Thiourea treatment resulted in a significant reduction in the average size of marketable and all tubers, with a reduction of 0.73 ounces and 0.61 ounces respectively. The Pontiac variety showed the largest reduction.

Thiourea treatment had no effect on either the amount of hollow heart or the percentage starch. It was detrimental to storage with tubers from thiourea treated plots breaking dormancy earlier than tubers from untreated plots.

Thiourea treatment slightly increased the tuber set and effectively reduced the tuber size. This resulted in reduced marketable and total yields with the Warba and Irish Cobbler varieties. The average size of Pontiac tubers was reduced without a reduction in yield. Thiourea may prove of value in controlling the tuber development with the Pontiac variety when the crop is to be disposed of in the fall or early winter.

LITERATURE CITED

1. American Chemical Paint Company, Technical Service Data Sheet H - 27, April 6th 1950.

2. Bewell, E.R. The determination of cooking quality of potatoes. Amer. Pot. Jour. 14: 235-242, 1937.

3. Casseres, E.H., Smith, Ora., and Ellison, J.H. Effect of thiourea on the number of stems, on the tuber set and on the yield of Katahdin, Kennebec and Sebago potatoes. Amer. Pot. Jour. 29 No.4. April 1952.

4. Chucka, A.J., Hawkins, Arthur., Brown, Bailey E., and Steinmetz, F.H. Size of whole and cut seed and spacing in relation to potato yields. Maine Agricultural Experimental Station. Bul. 439, December 1945.

5. Crocker, William. Growth of Plants. Reinhold Publishing Corp. 1948.

6. Cochran, W.G. and Cox, G.M. Experimental Designs. John Wiley and Sons, Inc. 1950.

7. Denney, F.E. Effect of thiourea upon bud inhibition and apical dominance of potatoes. Botanical Gazette 81: 297-311, 1926.

8. Eastman, P.J., and Libby, W.C. Green sprouting and thiourea treatment. Maine Agricultural Experimental Station. Progress Report 1947 - 1948, Bul. 460. P.53.

9. ---------- and Terman, G.L. Effect of thiourea on tuber size. Maine Agricultural Experimental Station. Progress Report 1948 - 1949, Bul. 473. P.50.

10. Hardenburg, E.V. Comparative studies of several potato treatments. Amer. Pot. Jour. 22: 1 - 5, 1945.

11. Hayes and Immer. Methods of Plant Breeding. Mc.Graw - Hill Book Co. Inc. 1942.

12. Murphy, H.J. Effect of treating seed potatoes with thiourea and Tubertone upon the subsequent tuber set and yield. Unpublished thesis. M.Sc. (Agronomy) University of Maine Orono, Maine, June 1950.

13. Smith, C.B. The effects of seed piece size and spacing relationships on the yield and quality of three potato varieties. Unpublished thesis, University of Manitoba, April 1945.

14. Smith, O.R., Hammel, F., and Kelley, W.C. Relation of rate and placement of fertilizer, variety, seed spacing and size of seed piece to yields of potatoes. Amer. Pot. Jour. 20: 267 - 277 (1943).

15. Steinbauer, G.P. Use of thiourea to control size of potato tubers. Maine Agricultural Experimental Station. Progress Report 1946 - 1947. Bul. 449: 323-325.

16. Terman, G.L., Libby, W.C., Cunningham, C.E., Strucktemeyer, R.A., and Goven, Michael. Effect of seed spacing, irrigation and thiourea on size and yield of potatoes. Maine Agricultural Experimental Station. Progress Report 1949 - 1950. Bul. 483, 52 - 53.

17. ----------, Cunningham, C.E., Goven, M.G., and Strucktemeyer, R.A. Rate of planting and thiourea treatment for seed potatoes in Maine. Maine Agricultural Experimental Station, Bul. 505. September 1952.

18. ----------, Cunningham, C.E., Jenkins, J.C. and Goven, Michael. Control of tuber size. Maine Agricultural Experimental Station. Progress Report 1950 - 1951. Bul. 491: 56 - 57.

19. Thornton, N.C. Elimination of apical dominance in the potato tuber. Proc. Amer. Soc. Hort. Science. V. 36: 572 (1938).

20. Werner, H.W. The hollow heart situation in the Russet Rural potato. Annual Proc. Potato. Assoc. of America 1926, P.45 - 52.

21. ----------, Hollow heart of potatoes: occurrence and test of thiourea seed treatments for prevention. Nebraska Agricultural Experimental Station. Jour. Series. No.51.

22. Woodbury, G.W. Effects of certain chemicals on apical dominance and rest period of Russet Burbanl Potatoes. Proc. Amer. Soc. Hort. Science. 36: 601 - 608 (1928).

APPENDIX

TABLE I - PERCIPITATION DATA FOR THE MONTHS OF MAY, JUNE, JULY, AUGUST AND SEPTEMBER, 1951 AND 1952

1951		1952	
Period	Percipitation in Inches	Period	Percipitation in Inches
May 1 - 7	.17	May 1 - 7	.03
8 - 14	.04	8 - 14	.02
15 - 21	.10	15 - 21	.01
22 - 28	.68	22 - 28	.31
29 - 31	-	29 - 31	-
Total	.99	Total	.37
Normal	2.07	Normal	2.04
June 1 - 7	1.02	June 1 - 7	.83
8 - 14	.16	8 - 14	.21
15 - 21	.01	15 - 21	.80
22 - 28	.91	22 - 28	3.19
29 - 30	.03	29 - 30	1.72
Total	2.13	Total	6.75
Normal	3.08	Normal	3.12
July 1 - 7	.19	July 1 - 7	.51
8 - 14	.32	8 - 14	.16
15 - 21	.55	15 - 21	.95
22 - 28	.13	22 - 28	.02
29 - 31	.43	29 - 31	.08
Total	1.62	Total	1.72
Normal	2.89	Normal	2.87
Aug. 1 - 7	.28	Aug. 1 - 7	.57
8 - 14	1.60	8 - 14	.13
15 - 21	1.49	15 - 21	.28
22 - 28	.71	22 - 28	.03
29 - 31	.15	29 - 31	.40
Total	4.23	Total	1.41
Normal	2.54	Normal	2.52
Sept 1 - 7	.37	Sept 1 - 7	.05
8 - 14	.28	8 - 14	.23
15 - 21	.16	15 - 21	.06
22 - 28	1.08	22 - 28	.05
29 - 31	-	29 - 31	.13
Total	1.84	Total	.52
Normal	2.19	Normal	2.17