

# AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE  
AND APPLIED SCIENCE  
MANHATTAN, KANSAS

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## SOME COLD STORAGE STUDIES OF KANSAS POTATOES



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## CONCLUSIONS

Potato producers who use cold-storage facilities may profit from this study by consideration of the following points:

1. Putting potatoes of U. S. No. 1 quality in storage is preferable to storing the lower grades.
2. Deterioration and shrinkage during cold storage are severe where decay and sun damage are among the potato defects.
3. About one-half the total shrinkage of good potatoes in cold storage over a six-month period will occur during the first few weeks. Therefore, potatoes should contain from 103 to 106 pounds per sack (depending on the storage period) if it is desired to market 100-pound sacks of potatoes out of storage.
4. Where cold storage conditions are ideal and potatoes are U. S. No. 1 quality, the use of closely woven cotton sacks will decrease the weight shrinkage compared with potatoes placed in burlap or open-mesh sacks.
5. Shrinkage in weight of washed and clean unwashed potatoes is about the same where the quality is uniformly good. Washed potatoes of low-grade shrink more and deteriorate faster in cold storage compared with unwashed potatoes.
6. Cold storage of potatoes may be desirable: (a) To avoid selling on a temporarily glutted market, (b) to remove field heat or to condition the potatoes so they will carry satisfactorily to market, and (c) to store for a longer period and to market the potatoes locally through established outlets such as local grocery stores at a time when potatoes are ordinarily shipped in.
7. To get the best results potatoes should be stored in cold-storage rooms where there is enough circulation of air to prevent moisture condensation on the potatoes after the first week or two of storage. Less shrinkage will occur with the minimum of deterioration if the relative humidity remains fairly uniform at 85 to 90 percent. The most satisfactory cold-storage temperatures for potatoes are near 45° F. Temperatures of less than 40° F. over a long period of time cause flavor changes.

## SOME COLD-STORAGE STUDIES OF KANSAS POTATOES<sup>1</sup>

FRANKLIN L. PARSONS<sup>2</sup>

### INTRODUCTION

The Kansas commercial potato crop for the most part is harvested and marketed within a three-week period starting during the latter part of June. As the crop matures and the vines begin to die the potatoes are harvested and marketed immediately to avoid loss from high temperatures.

Often when Kansas and Missouri producers have shipped large quantities of potatoes to the central markets the price has dropped sharply. Prices for these potatoes on the Chicago market often dropped 25 to 50 percent in a few days in early July, although prices of potatoes from other areas remained almost steady or declined only slightly. Because of this situation, a few Kaw Valley producers have experimented to a limited extent in recent years in putting potatoes in cold storage. This practice has been successful in some cases but not in others. Some producers have followed the practice of using cold-storage facilities for only a few weeks or until prices became more favorable. Others have used it for several months and sold out gradually to local buyers.

The costs of extra handling and of cold storage have been high relative to the value of the potatoes in most seasons. Some shrinkage in weight and deterioration during the storage period is to be expected. There also has been the prospect, that the general potato price level would decline seasonally until late fall. It is principally for these reasons that cold storage has not been practiced on a large scale by Kansas potato growers. On the other hand, when prices have declined for a short time due to heavy shipments or when a particular grower over a period of years has developed a local market outlet for a certain quality of potatoes, this method of marketing has been used successfully. It is under such conditions that information on condition and shrinkage of potatoes in cold storage is of particular value and interest.

### METHODS OF STUDY

Investigations of cold storage of Kansas potatoes were carried on over a three-year period—1939 to 1941, inclusive. Representative samples of washed and unwashed potatoes of the two principal varieties grown were purchased or obtained and placed in different type storages. Each season a different grade of potatoes was used. In

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2. Mr. Parsons is a Marketing Specialist on the staff of the Agricultural Experiment Station. S. W. Decker, Olericulturist and Florist, assisted in planning the study and obtaining part of the data. Others who assisted in the collection and tabulation of data were: Orrin J. Marcy, Wm. H. Winner, Harold Fox, and Raymond W. Hoecker.

one season unwashed Cobblers were stored in different type bags. A record of temperatures, relative humidity, and evaporation in several storage rooms was taken to determine weight shrinkage and deterioration under different conditions. Humidity data were taken by means of a sling psychrometer and also from a hygrograph. Temperature records were obtained with mercury thermometers and a recording thermometer. Evaporation was measured by standard wet bulb evaporation cups (atmometers). These porous bulbs or cups were about two inches in diameter and were fitted tightly into bottles containing a measured amount of water. The amount of water that evaporated was thus readily and accurately determined and the relative evaporation situation in the different storages determined. The evaporation through these bulbs gave an indication of the extent potatoes might be expected to shrink in weight by loss of moisture.

Except for 1939 when potatoes were obtained from the college experimental field at Newman, Kansas, potatoes selected were purchased direct from growers and placed under the same storage conditions producers were using. Federal inspections were obtained on most lots so that the grades of the potatoes were known.

#### QUALITY OF POTATOES AND STORAGE CONDITIONS IN 1939

Much of the 1939 potato crop was exceptionally poor in quality. Only 6.2 percent of total federal inspections—the lowest on record—showed U. S. No. 1 quality. Almost 10 percent—the second highest on record—failed to make any grade. The principal defects were scab, second growth, misshapen, mechanical injury, and sun injury.<sup>3</sup>

The potatoes stored in 1939 were obtained from the Newman, Kansas, Experiment Field of the Kansas Agricultural Experiment Station. They were of such poor quality that the federal inspector indicated the Cobbler variety as unclassified. The extent of the more important defects is indicated in Table 1.

Cold-storage temperatures did not vary more than two points from 42° F. The humidity fluctuated from 100 percent during the first few days of storage to near 75 percent at the end of the storage period. Cold-storage costs were 10 cents a hundred pounds (on a per sack basis) the first month and 5 cents a hundred pounds for each succeeding month.

#### SHRINKAGE AND DETERIORATION OF UNCLASSIFIED COBBLER POTATOES IN COLD STORAGE DURING 1939

Twenty-five sacks of washed Cobblers totaling 2,510 pounds and twenty-five sacks of unwashed Cobblers totaling 2,477 pounds were put into a cold-storage house in Topeka, Kansas, on July 21, 1939. Each lot was weighed at monthly intervals for six months. The washed lot shrank in weight a total of 379 pounds, or 15.09 percent over a period of six months and ten days. The unwashed lot shrank

3. Market Quality of Kansas Potatoes as Determined by Federal Inspection. F. L. Parsons. Bul. 298, p. 14. Kan. Agr. Expt. Sta., Manhattan.

a total of 253 pounds, or 10.21 percent (Table 1). The greatest shrinkage occurred during the first few weeks of storage and gradually decreased to the end of the storage period. Almost one-third of the total shrinkage occurred during the first 40 days in storage. More than two-thirds of the total shrinkage occurred by the middle of the storage period.

TABLE 1.—*Weight and shrinkage of unclassified Cobbler potatoes in cold storage during the 1939 season.*<sup>1</sup>

| DATE OF WEIGHING.  | Washed.                     |  | Unwashed.                   |  |
|--------------------|-----------------------------|--|-----------------------------|--|
|                    | Total weight<br>(25 sacks). | Percent<br>shrinkage<br>from original<br>weight. | Total weight<br>(25 sacks). | Percent<br>shrinkage<br>from original<br>weight. |
| July 21, 1939..... | <i>pounds.</i><br>2,510     | <i>percent.</i>                                  | <i>pounds.</i><br>2,477     | <i>percent.</i>                                  |
| Sept. 1, 1939..... | 2,398                       | 4.46   | 2,394                       | 3.35   |
| Oct. 1, 1939.....  | 2,334                       | 7.01   | 2,356                       | 4.88   |
| Nov. 1, 1939.....  | 2,260                       | 9.96   | 2,307                       | 6.86   |
| Dec. 1, 1939.....  | 2,213                       | 11.83  | 2,276                       | 8.12   |
| Jan. 1, 1940.....  | 2,163                       | 13.82  | 2,249                       | 9.20   |
| Feb. 1, 1940.....  | 2,131                       | 15.09  | 2,224                       | 10.21  |

1. Defects—(from federal inspector's report)
- Mechanical injury ..... 6 percent
  - Wireworm injury ..... 36 percent
  - Flea beetle injury ..... 26 percent
  - Misshapen ..... 5 percent
  - Heat or sunscald ..... 10 percent
  - Decay ..... 1 percent
  - Undersize ..... 1 percent

During the storage period, cut potatoes seemed to heal over well. The relatively large proportion having decay and heat damage deteriorated further during storage. After the final weighing at the end of the storage period, the potatoes were sorted and all that were decayed or unfit for human consumption were weighed separately. (Potatoes were graded also before the initial weighing.) Of the washed lot, 489.8 pounds—an average of 19.6 pounds per sack—were discarded. In the unwashed lot, 235.5 pounds—an average of 9.4 pounds per sack—were discarded. Also, those potatoes having bruised or insect injury were susceptible to decay organisms and deterioration during the storage period. Where there were defects (particularly of a pathological nature), the quality rapidly deteriorated. This was especially true of potatoes that were washed because during this process disease organisms were spread and the water apparently hastened breakdown and decomposition. The shrinkage in weight of washed potatoes of this quality was 50 percent more than unwashed potatoes and deterioration was approximately 100 percent more.

On the average, a 100-pound sack of washed Cobblers shrank a total of 15 pounds during the six-month storage period, and there was a further loss of 19½ pounds of rotted or otherwise worthless potatoes—a total loss of 34½ pounds per sack of potatoes. This compares with 10 pounds shrinkage and 9½ pounds of worthless potatoes—a total of 19½ pounds for an average unwashed sack of potatoes.

Thousands of sacks of potatoes were in cold storage with the experimental lot and casual observation indicated that other potatoes of low grade and quality had about the same deterioration as the lot studied. Most of these commercial potatoes were regraded and sold within a few weeks after entering storage, but in practically every case losses resulted. It is not profitable to put a poor-quality potato in cold storage except possibly for a few days to remove the field heat or to escape temporarily depressed markets.

#### QUALITY OF POTATOES AND COLD STORAGE CONDITIONS IN 1940

The quality of the 1940 potato crop was much better than the 1939 crop. Potatoes put in cold storage were of U. S. No. 1 quality according to federal inspection. They were purchased from a grower near Topeka and were selected at random. The potatoes were in storage five months and 21 days in commercial cold-storage houses.

In storage room No. 1, where the cooling coils were located outside the storage room, temperatures varied as much as 7° F. and averaged about 45°. The humidity averaged 87 percent of saturation with a comparatively wide weekly fluctuation during most of the storage period. There was a constant movement of air in this room which prevented moisture condensation on the potatoes. A total of 591 c.c. of water evaporated from the standard wet bulb evaporation cup in this storage room. In comparison with evaporation in the other rooms, this was relatively high.

Storage room No. 2 was cooled by means of coils within the storage room itself. Large fans were used to keep the air in movement and to prevent moisture condensation on the potatoes. Temperatures averaged near 42° F. with a weekly average range of less than 2°. Humidity averaged 88 percent of saturation with a range of less than three points from the weekly average after the first few weeks. A total of 380 c.c. of water was evaporated from the standard wet bulb evaporation cup or about 35 percent less than in the first storage room.

Storage room No. 3 was similar to No. 2 except that no attempt was made to circulate the air. Temperatures were held near 40° F. the first three months of storage and near 42° the last three months. Temperature was maintained within a 4° variation from the average. The humidity was at an average of 87 percent of saturation during the first half of the period but dropped slightly during the last half. The moisture evaporation in this storage was slightly less than in the second storage room—360 c.c.

TABLE 2.—Weight and percent shrinkage of washed and unwashed U. S. No. 1 Cobbler and Triumph potatoes in cold storage during the 1940 season.

| STORAGE PLACE AND DATES OF INITIAL AND FINAL WEIGHING. | Washed.                          |                                  |                                   |                                   | Unwashed.                        |                                  |                                   |                                   |
|--|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|
|  | Cobbler,<br>weight<br>(5 sacks). | Triumph,<br>weight<br>(5 sacks). | Cobbler,<br>percent<br>shrinkage. | Triumph,<br>percent<br>shrinkage. | Cobbler,<br>weight<br>(5 sacks). | Triumph,<br>weight<br>(5 sacks). | Cobbler,<br>percent<br>shrinkage. | Triumph,<br>percent<br>shrinkage. |
|  | <i>pounds.</i>                   | <i>pounds.</i>                   | <i>percent.</i>                   | <i>percent.</i>                   | <i>pounds.</i>                   | <i>pounds.</i>                   | <i>percent.</i>                   | <i>percent.</i>                   |
| <i>Storage Room No. 1:</i>                             |                                  |                                  |                                   |                                   |                                  |                                  |                                   |                                   |
| July 10, 1940.....                                     | 513.75                           | 509.00                           | .....                             | .....                             | 513.00                           | 508.75                           | .....                             | .....                             |
| Jan. 1, 1941.....                                      | 474.06                           | 475.13                           | 7.72                              | 6.66                              | 475.13                           | 475.81                           | 7.38                              | 6.47                              |
| <i>Storage Room No. 2:</i>                             |                                  |                                  |                                   |                                   |                                  |                                  |                                   |                                   |
| July 10, 1940.....                                     | 512.38                           | 510.44                           | .....                             | .....                             | 514.50                           | 509.44                           | .....                             | .....                             |
| Jan. 1, 1941.....                                      | 484.06                           | 480.44                           | 5.52                              | 5.88                              | 481.81                           | 481.06                           | 6.35                              | 5.57                              |
| <i>Storage Room No. 3:</i>                             |                                  |                                  |                                   |                                   |                                  |                                  |                                   |                                   |
| July 10, 1940.....                                     | 512.75                           | 508.81                           | .....                             | .....                             | 516.88                           | 510.25                           | .....                             | .....                             |
| Jan. 1, 1941.....                                      | 479.94                           | 482.25                           | 6.50                              | 5.22                              | 481.88                           | 482.38                           | 6.77                              | 5.46                              |

COLD STORAGE OF KANSAS POTATOES

**SHRINKAGE AND DETERIORATION OF U. S. No. 1 COBBLER AND TRIUMPH POTATOES IN COLD STORAGE DURING 1940**

Total shrinkage in weight during the storage period varied slightly between the different storage rooms and between the two varieties of potatoes. The shrink in weight varied on the average from about 5½ pounds to 7½ pounds per 100-pound sack. Loss of weight was slightly greater in the first storage room. In this room the loss of moisture from the evaporation cup was larger and the humidity tended to be somewhat lower and fluctuated more than in the other two rooms. It seems probable that if humidity had been held more uniformly at about 90 or 92 percent of saturation, shrinkage in potato weights would have been less. There was practically no deterioration of quality of potatoes in storage rooms Nos. 1 and 2. After the first few days of storage, both potatoes and sacks became dry. Cut potatoes or those with broken skins healed over nicely. At the end of the storage period there was no need for resorting or regrading. These potatoes were sold at a U. S. No. 1 price.

Loss of weight by shrinkage was least in storage room No. 3, averaging about 1½ pounds less per sack, compared with results from the other two storages (Table 2). No effort was made to circulate the air in room No. 3 and as a result, there tended to be some moisture condensation on the potatoes and sacks. It was necessary to resort part of these potatoes at the end of the storage period. The potatoes from this lot graded U. S. Commercial at the end of the storage period and sold at about one-half the price received for the other two lots.

**LOSSES BETWEEN VARIETIES**

With one exception, Triumphs shrank somewhat less in weight than did Cobblers in all three storages. On the average, Triumphs shrank from two-thirds of a pound to one pound per hundred-pound sack less than did Cobblers. This tendency may not necessarily be inherent in the variety but may be due to the fact that the two varieties came from separate fields where growing conditions may have been different. The data presented in Table 2 are not sufficient to make any definite conclusions concerning difference in varieties.

**RATE OF SHRINKAGE**

Nearly half the loss of weight by shrinkage of the U. S. No. 1 potatoes occurred during the first month of the period of 5<sup>2</sup>/<sub>3</sub> months (Fig. 1). For the storage period the total shrinkage of both washed and unwashed lots was 6.43 percent. After the first month, weight shrinkage varied from around one-half to 1 percent a month, due partly to the extent potatoes were moved into or out of the storage room and particularly during the last month when the relative humidity was lower in one or more storages.

Where potatoes were of good quality there apparently was practically no difference between washed and unwashed potatoes either

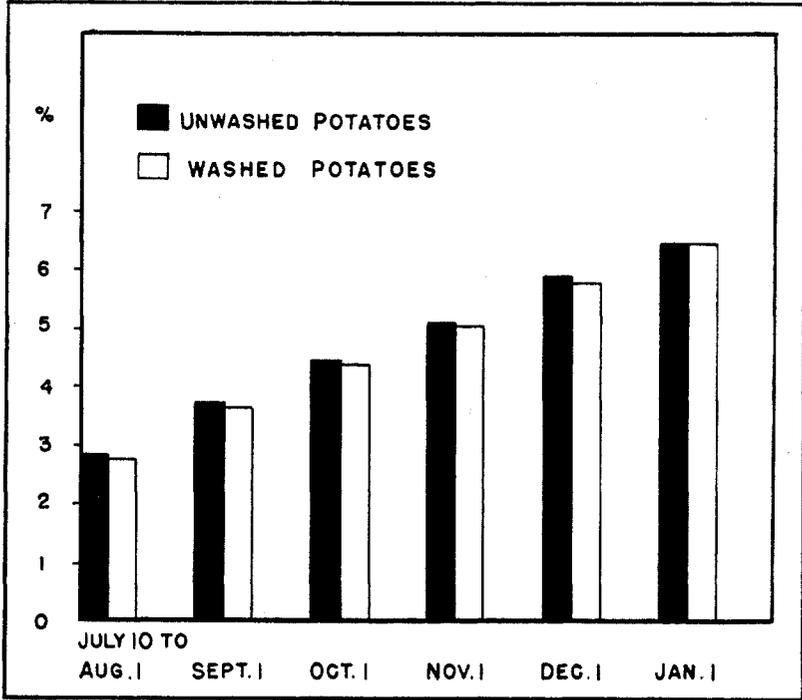


FIG. 1.—Percent shrink from initial weight of U. S. No. 1 potatoes in cold storage at Topeka, Kansas, in 1940.

in weight shrinkage or deterioration. This may be contrasted with poor-quality potatoes when washing apparently tended to increase shrinkage and deterioration during the storage period.

**EFFECT OF ULTRA-VIOLET TREATMENT ON KEEPING QUALITY OF POTATOES IN COLD STORAGE**

In some commercial vegetable growing areas, produce has been subjected successfully to ultra-violet rays as an aid in controlling or eliminating bacterial growth during storage or transit. An experiment was conducted with potatoes to find out if it might be advantageous to subject potatoes to this treatment before storage. The procedure was as follows:

| Under ultra-violet ray treatment              | Check group (Not under treatment) |
|---|-----------------------------------|
| One lot potatoes from diseased plants.....    | Same                              |
| One lot potatoes cut and bruised.....         | Same                              |
| One lot potatoes pitted and surface scab..... | Same                              |
| One lot potatoes bacterial rot.....           | Same                              |
| One lot potatoes no defects.....              | Same                              |

The five lots that were treated were under an ultra-violet light for about 5 days, July 15 to July 20, 1940. The facilities used were at

the new cold-storage house at the Kansas City, Kansas, Food Terminal. The lights were located near the ceiling and had been used for ripening and controlling fungus growth of meat. The potatoes were hung about 2 to 2½ feet away from lights. The sacks were turned frequently to get uniform treatment. The check group was placed in a similar room under the same conditions except for the lights.

After five days the ten lots were taken to a potato cold-storage house at Topeka, Kansas, where they were stored with other potatoes. On November 1, the treated and untreated lots were examined and several samples from each lot were cross-sectioned. It was impossible to detect any particular differences in keeping quality between potatoes that had been under the lights and those which had received no ultra-violet rays. It was concluded that the ultra-violet ray treatment had no effect on the keeping quality of potatoes with the given defects.

#### QUALITY OF POTATOES AND STORAGE CONDITIONS IN 1941

Cobbler and Triumph potatoes used for cold-storage experiments in 1941 graded U. S. Commercial. The Cobblers had defects which totaled 16 percent, compared to 20 percent for the Triumphs. The principal defects of both varieties were wireworm injury, hollow heart, second growth, bruises, sun burn, misshapen, scab, growth cracks, and a small amount of decay and dry rot. Red and White Warbas also were used for tests. These potatoes graded U. S. No. 2 and carried defects of 24 and 45 percent, respectively. About 75 to 90 percent of these potatoes had second growth or growth cracks which was the principal reason for failure to make the U. S. Commercial grade.

Experiments were conducted in two cold-storage rooms, designated as storage No. 1 and No. 2. These storage rooms were the same as those used the previous year. Temperatures in storage room No. 1 averaged slightly more than 44° F. for the six-month storage period July 24 to January 24. In room No. 2 temperatures averaged about 42°. Temperatures were kept nearly constant at these levels except for the first few weeks of storage when temperatures were gradually reduced from around 50° F. to the designated levels. Humidity and evaporation data in the two storage rooms are shown in Fig. 2.

#### SHRINKAGE AND DETERIORATION OF U. S. COMMERCIAL COBBLER AND TRIUMPH POTATOES IN COLD STORAGE DURING 1941

Weight shrinkage of potatoes in room No. 1 over a six-month period totaled 9.2 percent. This compared with 6.2 percent in storage No. 2 (Fig. 2). In room No. 2 a total of 293 c.c. of water evaporated during the test period compared with 510 c.c. for room No. 1. There were also wider and sharper relative humidity fluctuations in storage room No. 1 where the greatest weight shrinkage and moisture evaporation occurred. Probably a more constant and slightly

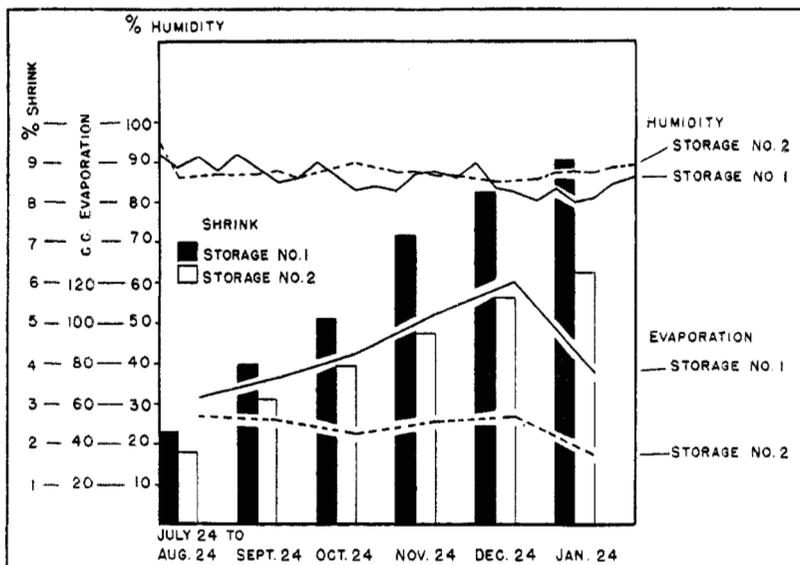


FIG. 2.—Shrinkage in potato weights, moisture evaporation by months and relative humidity during the cold-storage season in Kansas, 1941.

higher relative humidity in storage No. 1 would have decreased the difference in shrinkage by an appreciable amount.

There was slight deterioration in quality during the storage period but it was necessary to remove only a few decayed potatoes in only a few sacks. It was observed that about the only defect which caused serious trouble in storage was decay and heat or sun damage that resulted in decay. Practically all other defects remained dormant or, as in the case of cut potatoes, healing occurred.

Weight shrinkage of washed and unwashed U. S. Commercial grade potatoes in cold storage was practically identical—less than two-tenths of 1 percent difference for the six-month period for all Cobbler and Triumph potatoes. The 1940 data for U. S. No. 1 potatoes also showed almost identical shrinkage for washed and unwashed potatoes.

In 1941 as in 1940 (although not to quite the same extent) Triumphs shrank in weight somewhat less than Cobblers in all but one instance (Table 3). There was no specific effort made in this study to explain this difference. Possibly slightly different soil or moisture conditions under which the two varieties were produced accounted for the difference, or possibly it was due to varietal characteristics.

Red Warbas in storage No. 2 shrank in weight a total of 5.8 percent during the six-month storage period compared with 6.6 percent for White Warbas. Here again it is not known whether variations in shrinkage were due to conditions under which the potatoes were grown or to differences in variety.

TABLE 3.—Weight and shrinkage of washed and unwashed U. S. Commercial Cobbler and Triumph potatoes in cold storage during the 1941 season.

| STORAGE PLACE AND DATES OF INITIAL AND FINAL WEIGHING. | Washed.                    |                            |                             |                             | Unwashed.                  |                            |                             |                             |
|--|----------------------------|----------------------------|-----------------------------|-----------------------------|----------------------------|----------------------------|-----------------------------|-----------------------------|
|  | Cobbler, weight (5 sacks). | Triumph, weight (5 sacks). | Cobbler, percent shrinkage. | Triumph, percent shrinkage. | Cobbler, weight (5 sacks). | Triumph, weight (5 sacks). | Cobbler, percent shrinkage. | Triumph, percent shrinkage. |
|  | pounds.                    | pounds.                    | percent.                    | percent.                    | pounds.                    | pounds.                    | percent.                    | percent.                    |
| <i>Storage Room No. 1:</i>                             |                            |                            |                             |                             |                            |                            |                             |                             |
| July 24, 1941.....                                     | 498.50                     | 499.44                     |                             |                             | 490.50                     | 494.50                     |                             |                             |
| Jan. 24, 1942.....                                     | 451.00                     | 456.50                     | 9.5                         | 8.6                         | 446.44                     | 447.88                     | 9.0                         | 9.4                         |
| <i>Storage Room No. 2:</i>                             |                            |                            |                             |                             |                            |                            |                             |                             |
| July 24, 1941.....                                     | 496.88                     | 497.63                     |                             |                             | 489.19                     | 493.44                     |                             |                             |
| Jan. 24, 1942.....                                     | 466.25                     | 469.00                     | 6.2                         | 5.8                         | 456.50                     | 463.25                     | 6.7                         | 6.1                         |

**POTATO SHRINKAGE IN DIFFERENT TYPE BAGS**

The type of bag used apparently made considerable difference in weight shrinkage of potatoes in cold storage. Three lots of 5 sacks each of unwashed Cobblers were put in storage room No. 2. These potatoes were from the same source and stored under the same conditions as the other experimental potatoes. One lot was sacked in open-mesh bags similar to the type used by orange and grapefruit producers. Another lot was sacked in the ordinary burlap bag. The

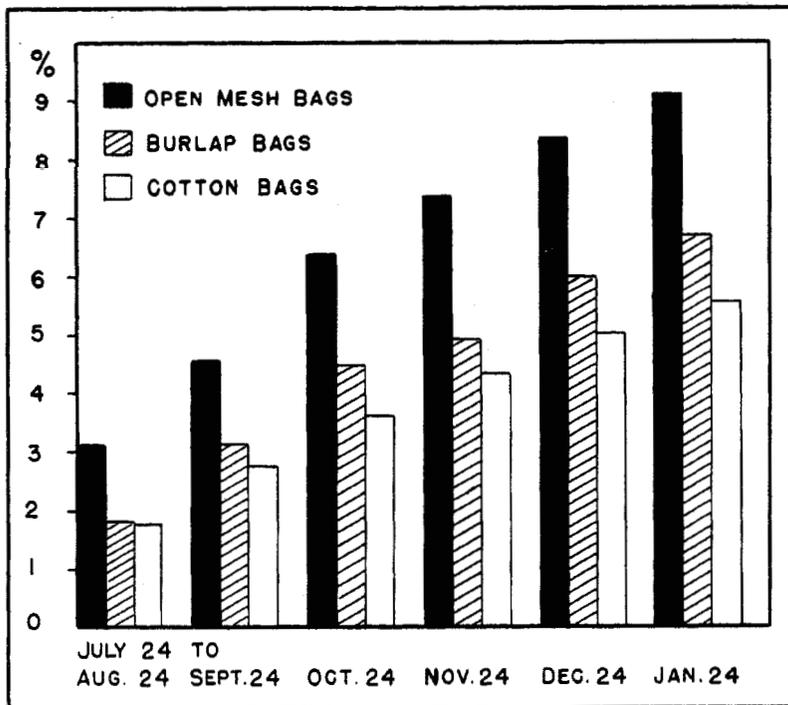


FIG. 3.—Percent shrinkage in weight of U. S. Commercial potatoes in different type bags during the 1941 cold-storage season.

third lot was sacked in closely-woven cotton sacks. The potatoes sacked in the open-mesh bags shrank approximately 25 percent more than those sacked in burlap and nearly 40 percent more than those sacked in closely-woven cotton sacks. This relationship applied fairly closely throughout the storage period (Fig. 3). During the first month of storage there was little difference in shrinkage between potatoes stored in the burlap and cotton bags. As the storage period advanced, however, the difference became significant. For the entire six-month period, potatoes in burlap sacks shrank in weight about 18 percent more than those in the cotton sacks.

Although the potatoes used in this particular test were not the same potatoes as those described in Table 3, it is interesting to note that the weight shrinkage of unwashed Cobblers in burlap bags was the same in both instances—6.7 percent. (All potatoes were in burlap bags except where designated differently.) No difference could

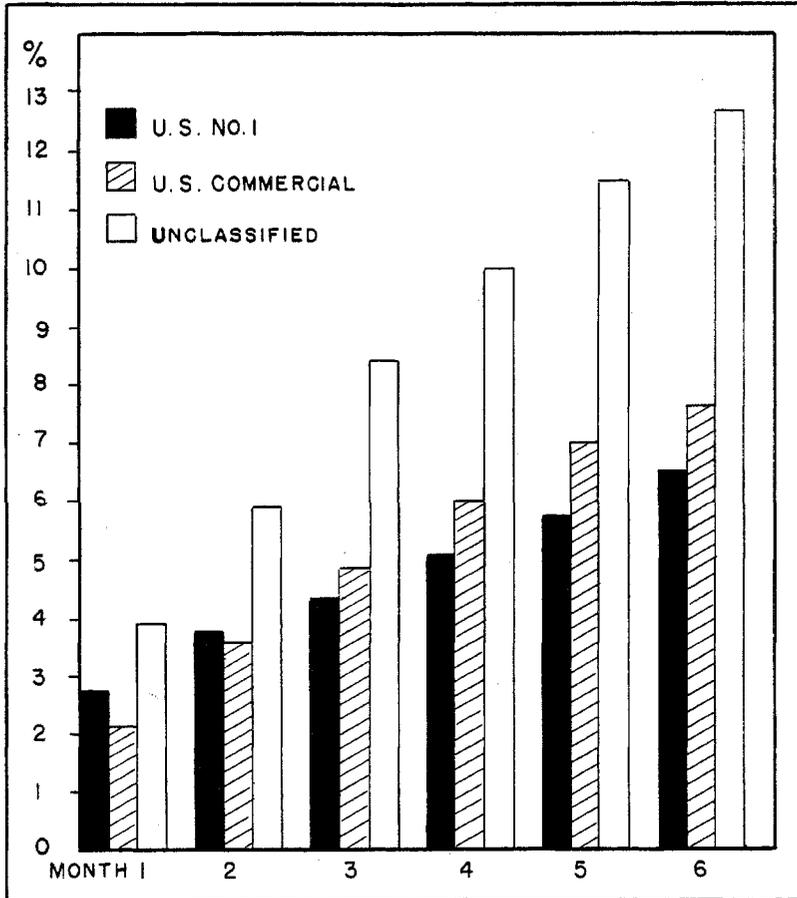


FIG. 4.—Percent shrink from initial weight of different grades of potatoes in cold storage at Topeka, Kansas, 1939-1941, inclusive.

be detected in keeping quality at the end of the storage period but this does not necessarily indicate that there may not be differences under less favorable storage conditions. There was proper ventilation in this storage room to prevent sweating or moisture condensation within the different types of bags used.

### POTATO SHRINKAGE BY FEDERAL GRADES

The shrinkage of the potatoes during cold storage varied greatly with the quality of potatoes stored, storage conditions, and the length of the storage period. In general, during a six-month period a poor quality of potato with relatively large sun damage and decay shrank in weight almost twice as much as U. S. No. 1 potatoes with practically no decay. Approximately two-thirds of the total shrinkage for the three grades occurred during the first half of the six-month storage period (Fig. 4). As the storage period lengthened, shrinkage increased most rapidly in the poorer grades (Fig. 4). Considering the greater deterioration during storage of poor-quality potatoes and the relatively larger shrinkage, it is doubtful if it pays to put lower grades of potatoes in cold storage except for a few days or weeks to precool the potatoes for shipment or to keep the potatoes off a glutted or poor market for a few days or weeks.

### SUMMARY

The bulk of the Kansas commercial potato crop in most years is harvested and marketed within a three-week period starting about the last of June. Temperatures usually are high and potatoes must be marketed or put in cold storage as soon as harvested.

Costs of cold storage may be prohibitive except under favorable circumstances. Costs usually have been 10 cents a hundred pounds the first month and 5 cents for each additional month. Shrinkage in weight and a seasonally lower potato price trend are factors to be considered in the cold storage of Kansas potatoes.

Cold-storage studies were conducted over a three-year period, 1939 to 1941 inclusive. Data were obtained on shrinkage and deterioration of washed and unwashed potatoes, different potato grades, principal varieties, and of potatoes stored in open mesh, burlap, and cotton sacks. The relationship between humidity, temperatures, and evaporation in relation to shrinkage and deterioration also was observed in separate cold-storage rooms.

The quality of the 1939 potato crop was exceptionally poor. The washed lot shrank 15.09 percent over a period of six months and ten days compared with 10.21 percent for the unwashed potatoes. About one-third of the total shrinkage in weight occurred during the first 40 days of the storage period.

At the end of the storage period for unclassified potatoes, an average of 19.6 pounds per sack of washed potatoes were worthless because of deterioration. This compared with 9.4 pounds for unwashed potatoes of this grade. The main cause of deterioration during storage was excessive decay and heat damaged tubers that had not been eliminated when graded before storage.

In 1940 potatoes put into cold storage for experimental purposes were U. S. No. 1 quality. Potatoes of this grade kept perfectly in cold-storage rooms where circulating air prevented moisture condensation on the potatoes. There was some deterioration of quality

in the storage where the air was not circulated. Washed and unwashed potatoes of U. S. No. 1 quality shrank in weight about the same in cold storage. Triumphs shrank about one-half to one pound per sack less than Cobblers but this may not necessarily be due to variety characteristics. Weight shrinkage was greatest where humidity varied considerably and evaporation was highest.

Over a period of five and two-thirds months in 1940, U. S. No. 1 potatoes shrank in weight an average of 6.43 percent. Nearly one-half of this shrinkage occurred during the first three or four weeks of storage. Two-thirds of the total loss of weight occurred during the first half of the storage period.

In 1941 potatoes used for cold-storage experiments were U. S. Commercial grade. Deterioration during storage was slight. Decay and sun damage were the only defects which caused trouble. These defects caused damage in only a few sacks and these potatoes were resorted.

Washed and unwashed potatoes of U. S. Commercial grade shrank in weight about the same amount in cold storage. Triumphs shrank slightly less than Cobblers. Weight shrinkage of these potatoes was 30 percent larger where humidity fluctuated from 10 to 12 percent than when humidity fluctuated less than 5 percent. Weight shrinkage was 9.1 percent over a six-month period in one storage room compared with 6.2 percent shrinkage in a second storage room. In the latter storage, only 293 c.c. of water evaporated from standard wet bulb evaporation cups compared with 510 c.c. in the former storage.

Kansas Cobbler potatoes which had common defects were treated under ultra-violet lights for several days at the beginning of the cold-storage period. It was impossible to detect any difference in keeping quality at the end of the storage period between the potatoes that had been under the lights and the check lots that had received no treatment.

During the six-month storage period in 1941, potatoes sacked in open-mesh bags (one-eighth to one-fourth inch openings) shrank in weight 25 percent more than potatoes sacked in ordinary burlap sacks and 40 percent more than potatoes sacked in closely woven cotton sacks. The quality of the potatoes remained the same in the different type bags.

Poor-quality potatoes containing decay and sun damage shrank in weight during six months in cold storage about twice as much as U. S. No. 1 potatoes. U. S. Commercial potatoes shrank in weight about 16 percent more than U. S. No. 1 grade. For all grades, from 30 to 46 percent of total weight shrinkage occurred during the first 30 to 40 days of the storage period and approximately two-thirds of the total shrinkage occurred during the first half of the six-month storage period.



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