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By H. B. Cordner

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
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Summary of Recommendations

Time of Planting Page 4

Use of early varieties is more effective than extra early planting in getting a crop before weather becomes too hot. Very early plantings are likely to result in seed decay due to low soil temperatures, or in delayed maturity due to destruction of well developed sprouts by late freezes. Freezing of sprouts soon after they emerge is usually of little consequence.

Seed Preparation Page 7

Cut deep, blocky sets with an average weight of 1 to 1½ ounces for planting 12 to 14 inches apart in rows 3 feet apart. With a wider planting distance, larger sets can be profitably used.

All seed potatoes should be treated with a good disinfectant such as corrosive sublimate or Semesan Bel to aid in control of scab and rhizoctonia. (CAUTION: These substances are poisonous.) Use of certified seed is necessary to avoid danger of the virus or mosaic diseases.

Sources of Seed Page 9

Certified northern-grown seed is usually satisfactory. Oklahoma seed from the previous fall crop has given good results when planted as cut sets. Oklahoma seed from the previous spring crop is usually less productive, and must be kept in cold storage for part of the interval between crops.

Varieties Page 11

Only early varieties are consistently successful. Triumph is the standard; but Warba and Red Warba are somewhat earlier and have outyielded Triumph in experiment station tests.

Irrigation Page 14

A few irrigations while the tubers are developing in May and early June may frequently mean the difference between a good crop and a failure. In experiment station tests, three or four irrigations during this period have resulted in doubling the yield of No. 1 tubers.

Fertilization Page 17

Potatoes on many soils in Oklahoma respond best to a fertilizer with a 1:2:1 ration, such as a 4-8-4, applied in the row at about 600 pounds per acre. The high potash fertilizers sometimes recommended for potatoes in other areas have not proved necessary in Oklahoma.

Harvesting Page 21

Early harvesting, although it means some sacrifice in total production, is often dictated by market prices or by weather conditions, especially high soil temperatures. Potatoes remaining in the ground during a period of hot weather in early July may spoil in the ground or decay later during storage.

Early harvesting means the tubers are immature and bruise easily. Every reasonable precaution must be taken to avoid damage by rough handling in harvesting and grading.

Sun scalding at harvest time is a hazard under Oklahoma conditions. Digging should be regulated so the tubers can be picked up and hauled from the field promptly after being turned out. Exposure to the sun for as little as a half-hour may cause considerable loss later, during shipment or storage.

Storage of Spring Crop Page 25

Refrigerated storage, following a "curing" period, is best. When cold storage is not available, an underground cellar or cave can be used if the temperature is held at a minimum (under 70° F. if possible) and a fairly moist temperature is maintained to avoid excessive shrinkage. All cut or seriously bruised tubers should be removed before storage.

Fall-Crop Production Page 28

Successful fall crops are most likely to be secured when fairly well matured seed from the spring-grown crop is stored in a cellar until the first part of August and then planted as recently cut sets. The planting, if possible, should be made when rainfall creates a break in the weather and provides low soil temperatures. Straw mulches or pre-emergence irrigations may also be used to secure lower and more favorable soil temperatures.

Irish Potato Production in Oklahoma

By H. B. CORDNER
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Irish potatoes are an important truck crop in Oklahoma,* and are also an important factor in the home food supply. Consequently, considerable work has been done at the Oklahoma Agricultural Experiment Station on the problems involved in the growing of this crop in the state. This bulletin presents the recommendations resulting from research covering the past 10 to 15 years.** It also incorporates recommendations from experimental work done elsewhere but applicable to Oklahoma conditions.

TIME OF PLANTING

Planting Date Is Important

Early planting of potatoes is essential in Oklahoma, because potatoes produce best when weather is cool and days are short. The plant develops best at temperatures of around 70° to 75° F., while tuber development is favored by temperatures of 60° to 65° F. *(7, 12, 14).*† At temperatures above 60° to 65° F., tuber production is reduced in proportion to the increase in temperature. Research *(13, 21)* has shown that tuber developing is also reduced by long days. In Oklahoma, therefore, conditions ordinarily become less favorable to the spring potato crop as the season progresses; and it is impossible to extend the potato season much beyond the first of July. Effect of planting date in one test is shown in Figure 1.

The best date of planting varies with each locality and with seasonal conditions. The best time to plant a spring crop is when the soil has warmed up enough to induce sprouting of the seed, but late enough to avoid late spring frosts. Sprouting is induced by soil temperatures of about 40° to 43° F., according

* The 1942 crop was 2,244,000 bushels grown on 33,000 acres. The estimated value was $2,939,640.

** The experimental work on which these recommendations are based is reported more fully in Oklahoma Experiment Station Bulletins B-249, "Fertilizers for Oklahoma Potatoes"; B-258, "A Study of Problems Relating to Production of Fall-crop Irish Potatoes in Oklahoma"; and Technical Bulletin T-18, "Experiments With Irish Potatoes; . . . "

†Italic figures in parentheses refer to "Literature Cited" on page 31.

to reports of tests made in Ohio *(8)* and Iowa *(13)*. Planting before the soil warms up to this temperature brings risk of a poor stand, because of decay of the seed pieces.

Favorable soil temperatures sometimes prevail ahead of the normal planting season, and a chance may be taken on

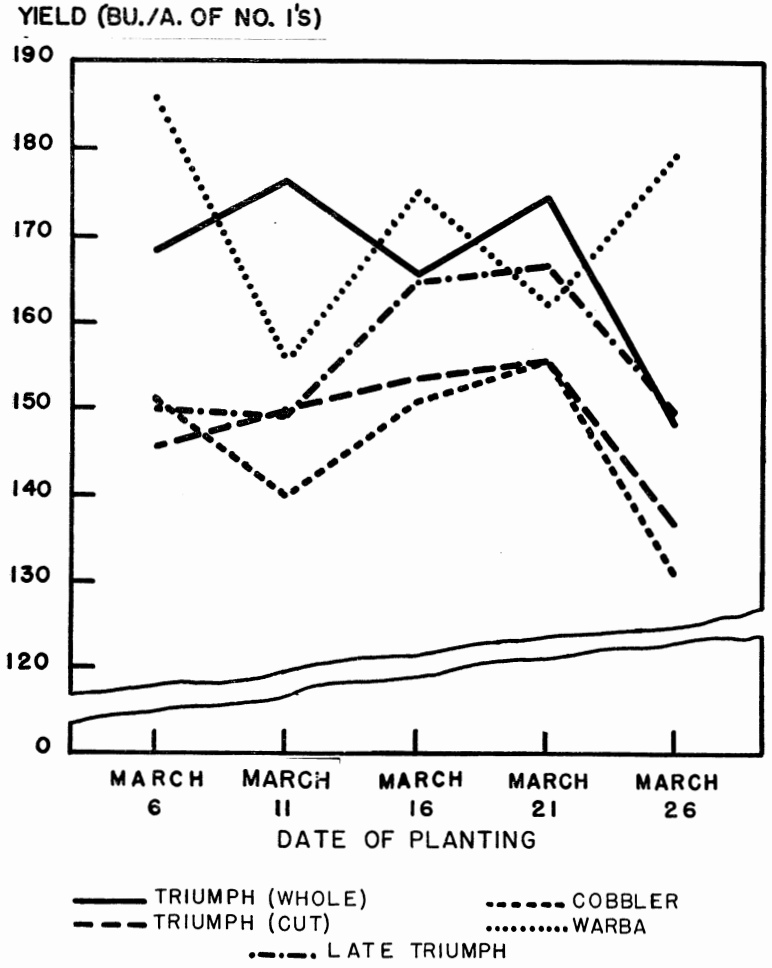

Fig.1.—These results from a time-of-planting test in 1939 illustrate the effects of late planting. Note the sharp decline in the production of No. 1 potatoes for some of the varieties for the last planting date (March 26).

avoiding damaging frosts if one cares to risk losing the seed. Some Oklahoma potato growers make extra-early plantings and protect the seed by covering to a depth of five or six inches. Whether this practice is profitable or not depends upon the season. These very early plantings frequently get up to a good stand only to encounter severe freezing which sets the crop back so much that nothing is gained. In general, extra-early planting is not advisable.

Effect of Late Frosts

Freezing back of potatoes is relatively common in Oklahoma, and there is some speculation as to its effect on the final yield. Naturally, there is a delay of a week or more after freezing in which the plants initiate and develop new shoots. The new growth comes from underground nodes on the frosted stem and as new sprouts from the seed piece. This usually results in an increase in the number of plants per hill and to some extent has the same effect as close planting. With a favorable season, and with ample moisture and soil fertility to support these extra plants, the freezing may actually be helpful in increasing yields. If the season is unfavorable, the competition between the several plants in each hill may result in the production of many, but small tubers, with a reduction in the marketable yield.

In a date-of-planting test at Stillwater in 1939, freezing of the plants early in the season, while they were small, did not reduce the final yield; but according to results of similar tests in Louisiana *(16)*, late freezing, after the plants have attained considerable size, is quite detrimental to the crop.

In general, the smaller the plants when frozen, the less is the chance of reduced yields. In the Louisiana tests, freezing soon after the plants emerged affected the crop little, while freezing after the plants had begun to form tubers completely destroyed the crop. Recovery from plantings made with 1½-ounce seed pieces was better than that for plantings made from smaller seed pieces (½- to 1-ounce sets).

Use of Early Varieties Advisable

It appears that the best solution to the late frost problem is the use of varieties which mature early, planting them at

the normal planting date. In the 1939 date of planting test, the variety Triumph was earlier than Cobbler, while the Warba matured slightly ahead of Triumph. Late strains of the Triumph variety are to be avoided. (See "Varieties," page 11.)

SEED PREPARATION

Cutting the Tubers

The general practice in commercial potato production in Oklahoma is to use northern-grown seed and to purchase large No. 1 tubers which are cut before planting. There is some variation in the size of sets prepared by different growers, and observations made at planting time indicate that in some cases undesirably small sets are planted.

The problem of seed preparation has been thoroughly studied at various experiment stations. It is apparent that the food materials are best utilized in the growth of sprouts when the sets are cut to a deep, blocky shape. Long, thin pieces and pieces of uneven size are also undesirable because they do not feed out uniformly in the planter and thus cause an uneven stand.

Each seed piece should contain sufficient reserve food to establish a good strong plant. Experience has shown that sets should weigh at least 1 ounce, and preferably 1½ ounces. The size of the set is usually varied according to the planting distance. With a 12-14 inch spacing in the row, sets weighing 1-1½ ounces are recommended. With wider spacing (14 to 18 inches), larger sets could be used advantageously.

In cutting seed potatoes one soon acquires the ability to judge the weight of the individual potatoes and to tell at a glance the number of sets to make from each. The apical or seed end of the potato has the greatest number of eyes and there is some indication that these eyes sprout more promptly than those from the basal end of the tuber. Therefore, in cutting potato seed it is recommended that one or more cuts be made through this end of the tuber.

Table I presents information relative to the quantity of seed required per acre for different planting distances and for sets of different sizes.

TABLE I.—Pounds of Seed Potatoes Required to Plant One Acre for Sets of Different Weights and for Different Planting Distances.

	AVERAGE WEIGHT OF SEED PIECES:		
	1 ounce	1½ ounces	2 ounces
Rows 3′, 8″ apart			
Sets spaced 10″	1224*	1836	2448
Sets spaced 12″	1020	1536	2040
Sets spaced 14″	876	1314	1752
Sets spaced 16″	768	1152	1536
Rows 3′ apart			
Sets spaced 10″	1066	1632	2178
Sets spaced 12″	906	1362	1812
Sets spaced 14″	780	1164	1554
Sets spaced 16″	678	1020	1362
Sets spaced 18″	606	906	1212
Rows 3′, 4″ apart			
Sets spaced 8″	1236	1854	2472
Sets spaced 10″	987	1464	1956
Sets spaced 12″	798	1200	1596

* To convert to sacks (100 lbs. each) mark off two decimals. Thus 1124 pounds becomes 12.24 or approximately 12¼ sacks.

Treating Seed to Prevent Disease

The potato crop is subject to a number of seed borne diseases, including the virus or mosaic diseases. These latter diseases are eliminated only by field inspection and rogueing, therefore only field inspected certified seed is recommended. It is not possible to ascertain the seed value of potatoes by inspection in the bin or bag alone.

All seed potatoes should be treated with a good disinfectant such as corrosive sublimate or Semesan Bel before planting to aid in the control of scab and rhizoctonia.* (CAUTION: These substances are poisonous and should be used only with proper care.)

* For more detailed information about treatment of seed potatoes, see Oklahoma Experiment Station Mimeographed Circular No. 36, "Disinfecting Irish Potatoes for Seed." This may be obtained by writing: Plant Pathology Department, Oklahoma A. and M. College, Stillwater, Oklahoma.

SOURCES OF SEED

Oklahoma-grown Seed

Commercial potato growers in Oklahoma depend on the northern seed crop because of the difficulty of storing the Oklahoma spring crop and the uncertainty of the fall crop. However, either spring- or fall-grown Oklahoma stock is sometimes used if on hand at planting time.

FROM SPRING CROP.—Spring-crop seed should be kept in cold storage for a part of the interval between crops, since sprouting of the tubers begins in common storage in the fall and before temperatures are low enough to check sprout growth. At planting time in late February and March, this seed may be shriveled to some extent and has some tendency toward multiple sprouting (Fig. 2), due to the loss of apical dominance (See "Importance of Age of Seed," page 10). In three out of four tests at the Oklahoma station, spring-grown Oklahoma seed was less productive than northern seed for this reason. Similar results are reported from tests conducted in Louisiana *(15)*.

FROM FALL CROP.—Fall-grown tubers store well in common storage and exhibit good apical dominance at planting time in the spring. They are somewhat slow to sprout; and cutting the seed therefore hastens sprouting and increases production. In Oklahoma Station tests, fall-grown Oklahoma seed planted as small whole tubers has been less productive than when planted as cut sets of similar size. Cut sets from fall-crop Oklahoma seed were only slightly less productive than northern-grown (Minnesota) seed, and in some cases were

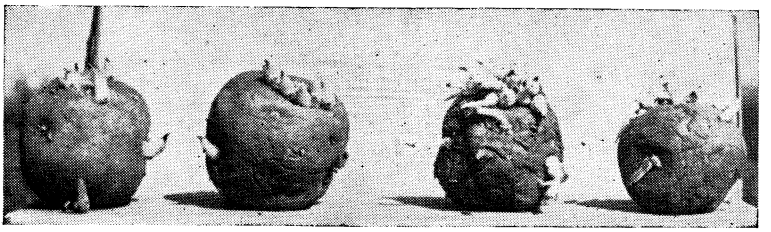

Fig. 2—Spring-grown tubers when held over for planting the following spring may be shriveled to some extend and usually exhibit symptoms of multiple sprouting.

equal to the northern seed. Seed grown at Texline, Texas, and at Goodwell, Oklahoma, was found in 1942 to be equal in value to the fall-crop seed grown on the Station farm at Perkins.

Northern-grown Seed

As noted above, northern-grown seed is commonly used for commercial spring plantings in Oklahoma; and such seed was used as the standard of comparison in all Station tests.

Tests with Nebraska Triumph seed indicate that the important factor in seed potatoes is the inspecting and the rogueing of the seed crops to eliminate disease and that the seed value is affected little by quality of the tubers as measured by the U. S. standard grades. In a comparison of different grades of Nebraska Triumph seed (two season's results) no differences in seed value were found. With seed treatment to control scab, the lower grade (White Label) seed appeared to be as desirable as the U. S. No. 1 (Blue Label) seed.*

This result should not be interpreted to mean that cheaper uncertified seed is recommended as being as desirable as certified seed. In two seasons, unsatisfactory yields were secured with state inspected but not certified Warba seed from northern sources, apparently because of diseases that cannot be controlled except by careful rogueing during the growing season.

Tests of irrigated in comparison with dry-land Triumph seed were for only one season and no significant differences in yield were found, although the actual yields for the dry-land seed exceeded those for the irrigated stock.

Importance of Age of Seed

The Irish potato tuber morphologically is an underground stem which functions in food storage. The eyes might be considered as nodes on this stem, and each eye is composed

* As described by the Nebraska Certified Seed Growers, seed stock sold with the above labels has all been given careful inspections in the field for disease, and therefore differs mainly in grade. Blue Tag stock meets the requirements for U. S. No. 1, Red Tag stock grades as U. S. Commercial (80% No. 1) while White Tag stock, because of size, scab or other defects, does not meet the above standards.

of a cluster of buds. Like other plant stems, the potato tuber has a distinct rest period; and thus a period of time (1 to 3 months) must pass after harvest before the tubers will develop sprouts. At the time sprouting begins (when the rest is completed), the tubers are apically dominant; that is, in whole tubers only the terminal eye on the "seed end" of the tuber sprouts. If the tubers are cut into sets, but one bud develops on each piece or from each eye.

With the passing of time this apical dominance is slowly lost and a condition of multiple sprouting arises. Each eye on the tuber may develop sprouts, and with cut sets several buds in each eye may develop sprouts. Usually the vigor of the individual sprout decreases as multiple sprouting increases; and investigations such as those of Appleman *(1, 2)* have suggested that tubers possessing good apical dominance are best and that the value of the tubers for seed purposes declines as the apical dominance is lost. With multiple sprouting in the seed, the number of plants per hill is increased; and this, as pointed out above in discussing the effects of late freezes, has the same effect as close planting and may be a disadvantage.

VARIETIES

As previously discussed, because of high temperatures in June, only early varieties of potatoes are consistently successful in Oklahoma. The variety Triumph (Figure 3) has long been a standard, with limited plantings made to Irish Cobbler. Generally the red tubers of the Triumph type are preferred on the northern markets and sell for a higher price than tubers of white varieties.

A number of improved varieties have been introduced in recent years, but, unfortunately, many of these are mid-season too late in maturing and thus are not adapted to the short growing season in Oklahoma. Therefore, in spite of a greater potentiality for production, these varieties may yield less than Triumph under Oklahoma conditions.

In Oklahoma Station variety trials, the only competitors of the Triumph have been the Warba varieties. In these tests, both the Warba (Figure 4) and the Red Warba (Figure

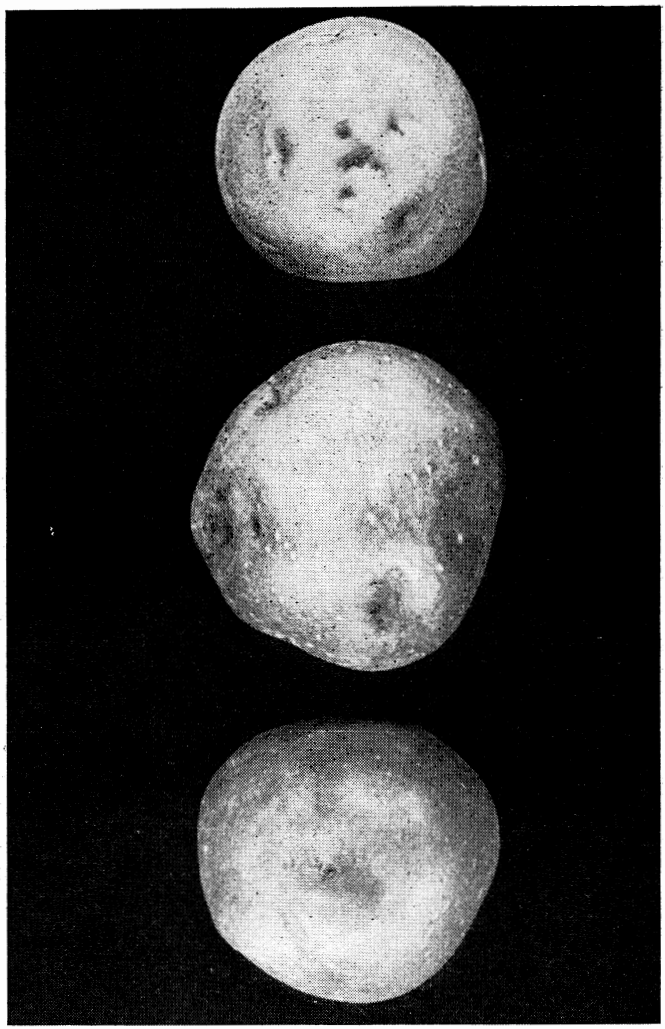

Figure 3.—Bliss Triumph.

Maturity: One of the earliest red varieties.
Tubers: Round, blocky; eyes of medium depth; table quality fairly good.
Use: Widely planted in Oklahoma for shipping to Northern markets and for home use.

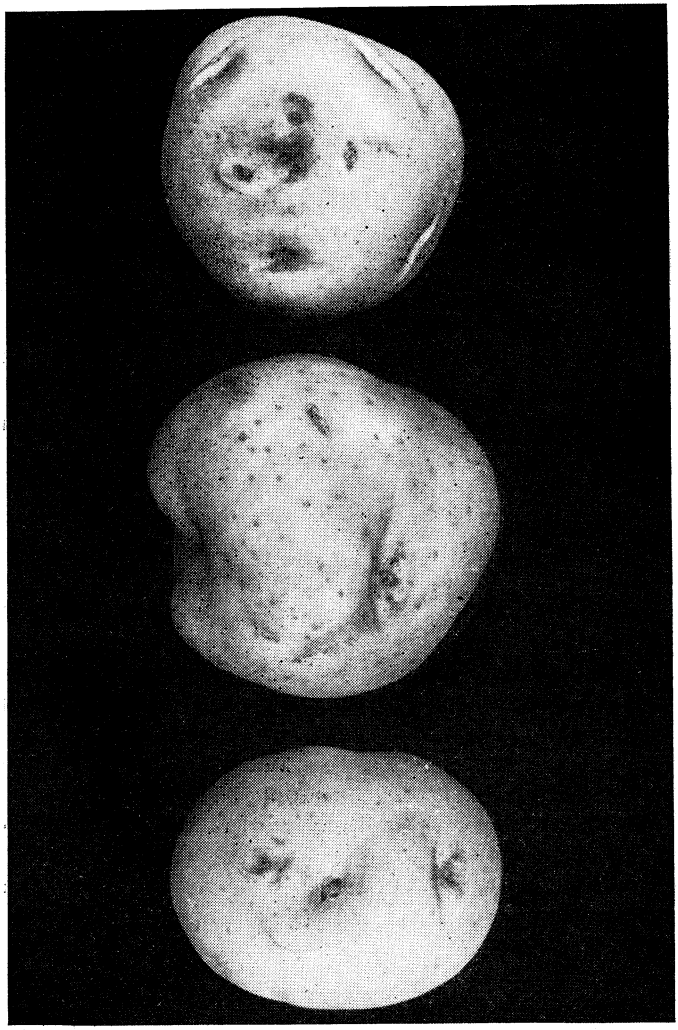

Fig. 4.—Warba.

Maturity: Earlier than Bliss Triumph.
Tubers: White with pink around eyes; blocky shape with fairly deep eyes.
Use: For home planting and for shipping to Northern market where the Irish Cobbler is acceptable. Earlier, more productive, and preferable to the Cobbler.

5) have been earlier in maturity and as an average are more productive than the varieties Triumph and Cobbler. The Warba, a white potato, is best adapted for home use and for markets which give preference to white potatoes. The Red Warba is desirable for home use and for shipping to those northern markets where red potatoes are preferred.

To test the value of the Warba as a market potato, the Oklahoma Station made small commercial plantings of White Warbas and Triumphs in 1939 and shipped three carloads to the Chicago market. Although the Warbas sold for only $1.60 per hundredweight as compared to $1.75 for the Triumphs, the yield of the Warbas was enough larger to make them the more profitable.

The Houma (Figure 6) has a very desirably smooth tuber, is a little late for best production in Oklahoma, but appears to be as productive as Cobbler and is of much better quality.

IRRIGATION

Irrigation water may be used to a good advantage in potato production in Oklahoma, and irrigation is already being successfully practiced by a few growers. The moisture supply in the soil is usually ample at planting time in March, and rainfall for April is generally sufficient to supply the crop with moisture throughout this early season. During May and early June the crop requires a greater supply of moisture for best development, and it is during this season that a moisture shortage is likely to develop because of insufficient rainfall. A few timely irrigations at this critical time, while the tubers are developing, may frequently mean the difference between a good crop and a crop failure.

In comparisons of irrigated and unirrigated potato plots at the Oklahoma Station, four irrigations in 1939 increased the total yield about 50 percent and also increased the percentage of No. 1 tubers. In 1940, irrigation increased the total yield 70 percent and doubled the yield of No. 1 tubers; and similar results were obtained with three irrigations in 1942. Abundant rainfall in 1938 made irrigation unnecessary that year.

The most practical and economical way to irrigate potatoes is by means of furrows between the rows. When the water is

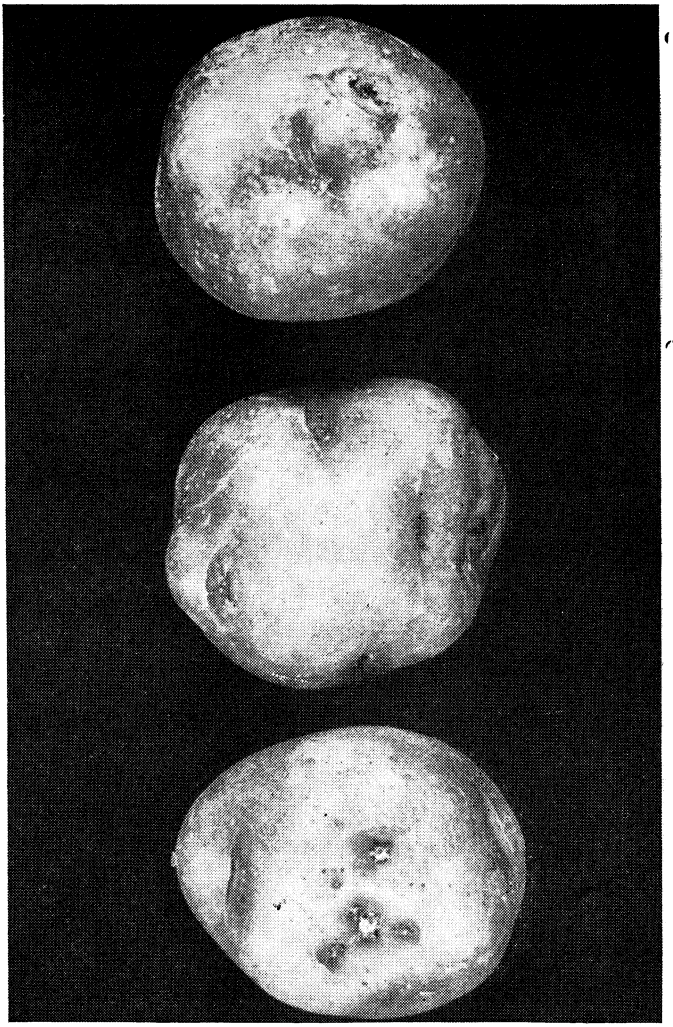

Fig. 5.—Red Warba.

Maturity: Same as Warba and earlier than Triumph.

Tubers: Deep red, attractively colored; blocky shape with fairly deep eyes. Has some tendency to revert back to white type. Variegated seed tubers should be avoided.

Uses: For shipping to the Northern market and for home plantings. Red color makes it desirable for shipping purposes and it is more productive than Triumph.

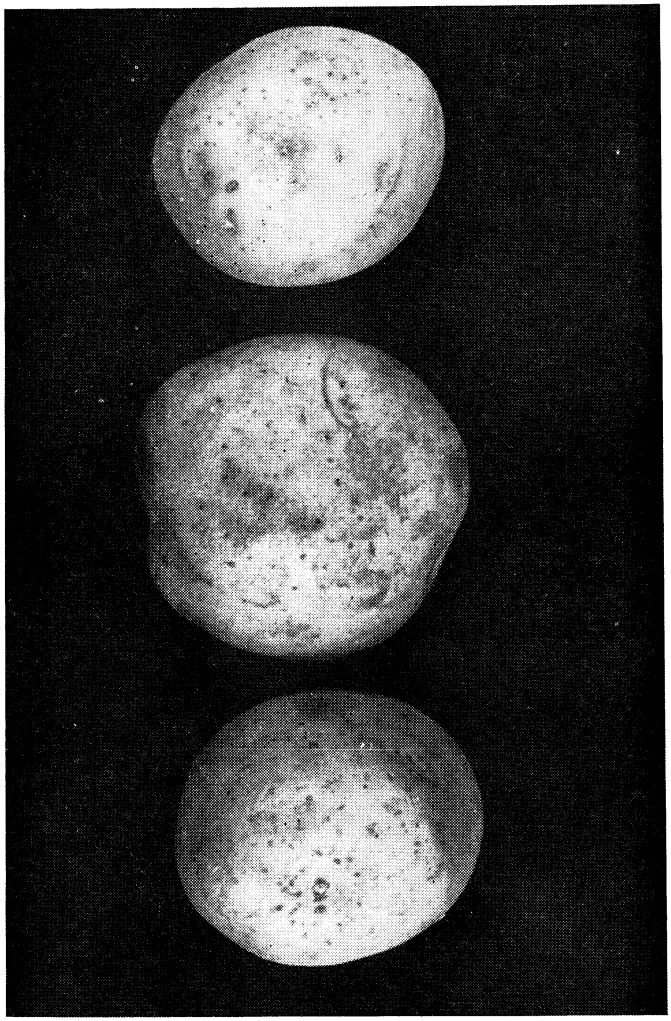

Fig. 6.—Houma.

Maturity: Mid-season; later than Cobbler but usually as productive.

Tubers: White; smooth with shallow eyes, rounded to oblong flattened; of good table quality.

Uses: Recommended as a substitute for Cobbler for home or market plantings. Smoothness of tubers and good quality make it more desirable than Cobbler, and in favorable seasons it is more productive.

applied in this way, some attention must be given to laying out the field in order to get the proper flow of water in the furrows. The field must be almost level or the rows run on the contour in such a way as to get a fall of one or two inches for a run of 50 feet. When these requisites for furrow irrigation cannot be met, it is necessary to use an overhead spray system. To spray irrigate one must have the water under pressure (30 to 40 pounds) and have a distributing system of pipes and sprinkler heads. The investment of motors, pump, pipes and sprinklers, plus the pumping cost, necessarily decreases the net returns from irrigations applied as an overhead spray.

Centrifugal pumps are most economically used for lifting water from streams, ponds, and shallow wells for irrigating and for operating sprinkler systems.

Portable pipe of 3- to 6-inch diameter is used to convey water to the field and as distributing lines in the field in connection with the rotating sprinkler heads. A few hundred feet of portable irrigation line may be used to cover a large acreage. This portable pipe is made up of light material and in convenient lengths of 16 to 20 feet so that the lines may be quickly assembled at one location and easily removed and reassembled at a new location.

FERTILIZERS

Commercial potato production in Oklahoma is confined largely to the river valleys where fine sandy and sandy silt loam soils are found. In many areas these soils are deep and were originally quite fertile; but many years of intensive cropping has reduced their fertility. Tests conducted by the Oklahoma Agricultural Experiment Station *(6)* at eight locations throughout the potato growing centers of the state show that applications of commercial fertilizer are definitely profitable. (See Figure 7.)

Kind of Fertilizer

In the majority of the tests it was found that a fertilizer having a 1:2:1 ratio, as found in a 4-8-4, 5-10-5, or 6-12-6, was best. In a few of the lighter soils a little more nitrogen was desirable; this would be provided by a *6*-8-4 (ratio 1.5-2-1). In a few instances a 1:3:1 ratio, as provided by a 4-*12*-4, was

Fig. 7.—The right fertilizer produces profitable crop increases.
Center: No fertilizer; yield 37 bushels per acre.
Right: 800 pounds of 4-4-4; yield 120 bushels per acre.
Left: 800 pounds 4-6-4; yield 143 bushels per acre.
An average of Oklahoma tests indicates that 600 pounds of 4-8-4 is usually most economical.

found desirable. Only one of the many tests conducted indicated that it was desirable to increase the potash above the nitrogen as is found in a 4-8-*6*. On the other hand, it was found that when dry seasons were encountered the high potash fertilizers were detrimental to the crop. This is of special interest since certain high potash fertilizers such as 4-8-6 and 4-8-10 are designated on the market as special potato fertilizers.

It appears that a general recommendation is a 1:2:1 ratio fertilizer such as a 4-8-4, 5-10-5, or 6-12-6. The latter two, which are more concentrated, may be the most economical. At times more nitrogen than provided in a 4-8-4 may be necessary and a 6-8-4 would be advisable. On some of the heavier soils a 4-12-4 is to be recommended; and in a few isolated areas on the lighter soils the potash may be depleted to the point that a 4-8-*6* would be best.

Amount to Apply per Acre

The question of rate of applying fertilizers has been quite extensively studied, and here again varying results have been obtained. Soil in which the nutrients and organic matter have been maintained by crop rotations and the production of green manure crops requires relatively less fertilizer to maintain good production in potatoes. When the soil moisture supply is not a limiting factor, a greater quantity of fertilizer can be utilized by the crop.

As an average for the several tests conducted, a quantity equivalent to 600 pounds of 4-8-4 fertilizer per acre proved to be most economical. This quantity does not always produce maximum yields, but usually the increase in production for higher rates does not pay for the cost of the additional fertilizer. In some of the more fertile soils, 400 pounds per acre would suffice; while in other areas as much as 800 pounds may be profitably used.

Method of Application

When less than 1000 pounds of fertilizer per acre is applied, to be most effective it must be applied in the row. However, care must be taken to prevent direct contact between the seed pieces and the fertilizer, since the seed piece or sprouts may be injured.

Various methods are used in seeding and fertilizing potatoes, but at present the preferred way is by means of the combined planter-fertilizer drill which places the fertilizer in the furrow in bands about two inches to the side of the sets where it is entirely safe. These machines are recent developments and are highly desirable in potato production. They complete the planting and fertilizing of the crop in one operation, and they put the fertilizer near the seed piece where it gives the maximum stimulation to the crop early in the season. At the same time, they place the fertilizer so that possible injury to the sprout is avoided.

The machine shown in Figures 8 and 9 is especially desirable since it also plants and places fertilizer with other crops such as beans, peas, corn, etc. The potato planting attachment is removed and a seed hopper is attached which

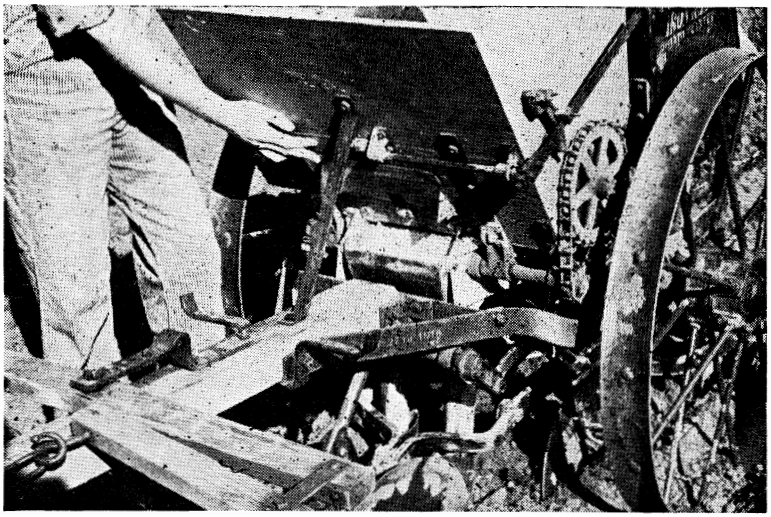

Fig. 8.—Side placement is proving to be a highly desirable method of distributing fertilizer on potato crops. The fertilizer is drawn out of the hopper on a canvas belt, divided between the two sprouts shown below. and deposited in the soil as a band to each side of the sets.

Fig. 9.—Potato planter with band fertilizer distributor in action. This is the machine shown close up in Figure 8.

operates with different plates and gears so any desired rate of seeding may be attained. Figure 10 illustrates the manner in which this machine distributes the fertilizer in the row in planting potatoes.

HARVESTING

Time of Harvest

As has already been suggested, the potato crop in Oklahoma is seldom left in the field to attain full maturity. A better price during the early part of the season sometimes encourages early harvesting, and in most seasons it is not safe to leave potatoes in the field too late because of the risk of damage by high soil temperatures.

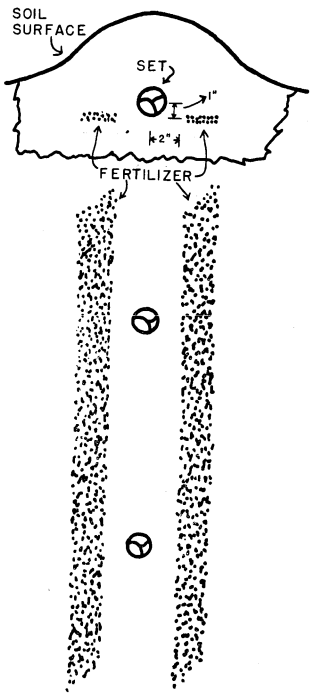

Fig. 10.—Relative position of fertilizer and seed piece in the band placement method of application. Top: Cross-section through row; bottom, looking down on row.

Early harvests are made with some sacrifice in total yield, and thus a gain of a few cents per bag in the early market would not represent a net gain to the grower. Data secured in a time of harvest test conducted in 1938 illustrate this point. In a crop planted March 11 and harvested at intervals beginning on June 15, the marketable yield was increased by about 22 per cent between June 15 and June 27. This increase was due in part to an increase in the proportion of potatoes making the marketable grade. Potatoes still in the ground when a period of hot weather occurred July 2 to 10 were almost a total loss. About one-third developed rots and were left in the field; one-fifth more were graded out after harvest because of decay; and the remainder soon decayed in common storage.

Occasionally the spring crop will be damaged in grade because of wet rather than dry soil conditions existing just prior to harvest. This results in a rough, "scurfy" surface on the tubers (Figure 11.) Second growth from a wet period following a dry one results in the knobby potatoes shown in Figure 12.

Avoiding Injury to Tubers

Because potatoes are harvested in an immature condition the skins are easily injured by handling during harvesting and grading. This partial peeling of the tubers not only detracts from their appearance but greatly increases the shrinkage or loss in weight and increases the tendency for the tubers to decay. Every reasonable precaution should be taken to avoid this injury. Wire baskets are best with padded rims or entirely lined with burlap. Diggers and graders should be padded where sharp or rough parts come in contact with the tubers. A new grader is now on the market which is equipped with rubber spools and rollers and rubber covered rods, so that all contact made with the tubers is cushioned and injury is reduced to a minimum. When an elevator type of digger is used, it should be adjusted if possible so as to carry some soil over to cushion the potatoes, and the speed should be reduced when the dryness of the soil makes it impossible to have this soil cushion.

Sun Scald

SERIOUSNESS IN OKLAHOMA.—One of the most serious hazards to the potato crop at harvest time is the possibility of scalding. Potatoes left in the field for some time exposed to the sun are injured; and later, in transit or storage, the outer tissues take on a soft, grayish, watersoaked appearance, with the injured area marked by a dark margin. Such tubers soon break down and decay.

Research by the United States Department of Agriculture *(17, 18)* has shown that scalding of the tubers is caused by exposure to direct sunlight. Thus total light intensity is the factor more closely related to the scalding. The Oklahoma potato crop is harvested in mid-June at a time when the days are longest and solar radiation is highest. The tubers are usually

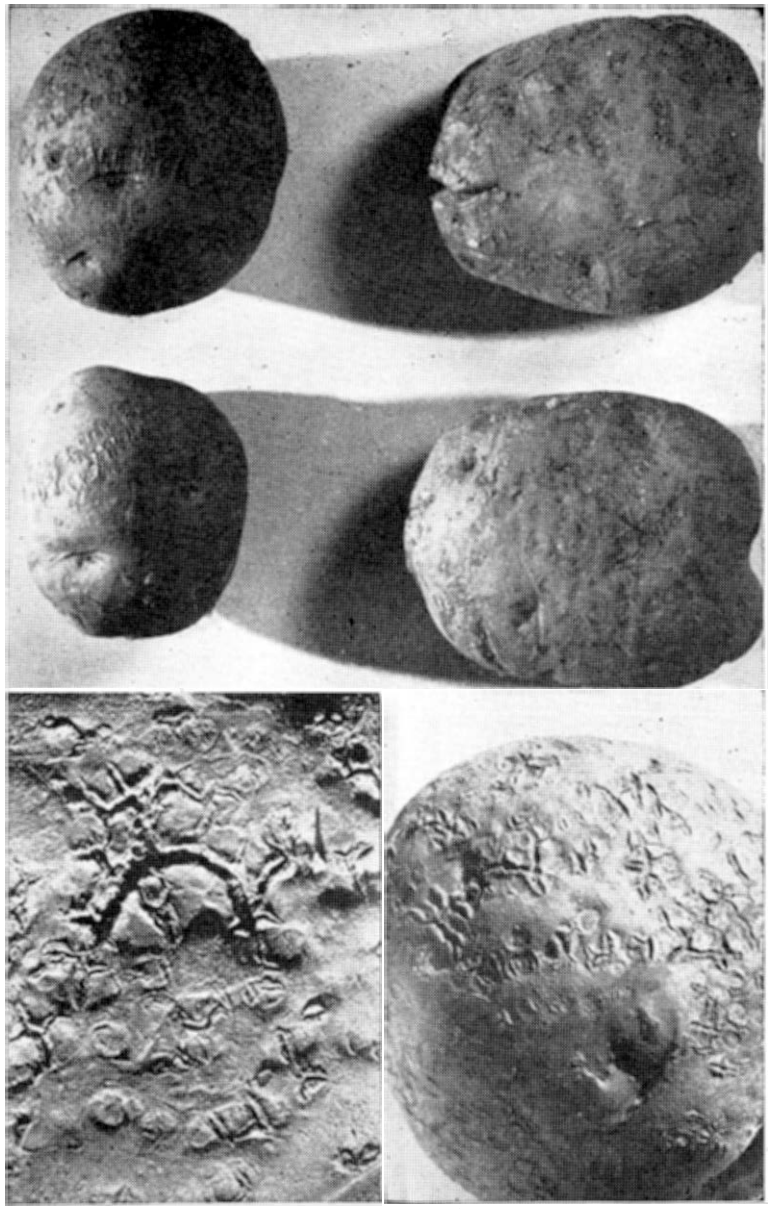

Fig. 11.—Heavy rainfall and a wet soil late in the season cause raised lenticils and a rough "scurfy" surface on potato tubers.

immature, with thin periderms, and are injured to some extent in digging. All of these conditions, the U. S. D. A. research showed, makes potatoes more susceptible to scald injury.

AVOIDING SUN SCALD INJURY.—From the above discussion, it appears that there are certain fundamental things the potato grower must understand with reference to tuber scald:

First, it relates to light intensity, and therefore actual air temperature or the way in which a human being is affected by the heat are not always a reliable indication relating to tuber scald. The light intensity is the sum total of solar radiation (direct) and sky radation (reflected), and thus one may be deceived on partly cloudy days when the total radiation or intensity is increased in localized areas by light reflected from the clouds.

Second, the mid-day period (10:00 a. m. to 3:00 p. m.) is the scald period, and an exposure of perhaps one-half hour or less at this time will induce scald.

Third, the scald does not show up for some time after the exposure; thus it may not develop until the tubers are shipped out, making the shipment a total loss.

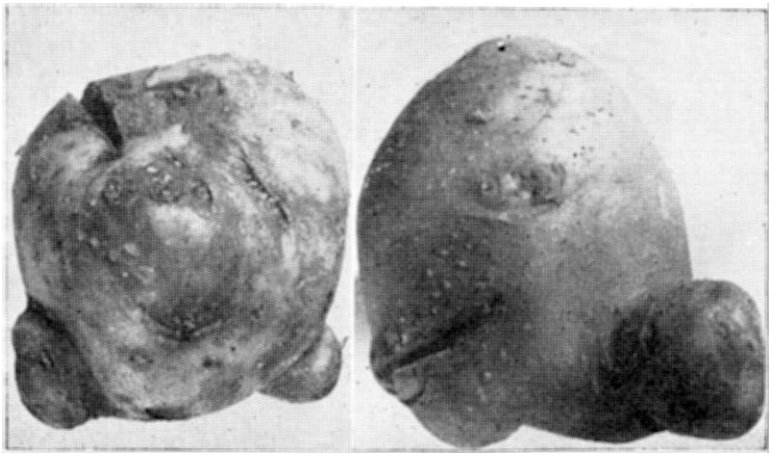

Fig. 12.—Second growth producing knobby potatoes and growth cracks (left) result when dry periods are followed by abundant rainfall.

There is but one solution to this problem, and that is to regulate the digging operation so that the tubers may be picked up and hauled from the field promptly after being turned out.

STORAGE OF SPRING-CROP POTATOES

The storage of potatoes harvested in the spring is primarily of interest to the home gardener and to growers who wish to keep a supply of potatoes on hand for home use. The large commercial acreage is planted largely for marketing at harvest time and there is little if any need for storing this crop.

Storage studies conducted over a three-year period at the Oklahoma Station indicate that potato tubers from the spring crop do not keep well in common storage and that temperature is the most important single factor. At 50° F. there is practically no decay and normal shrinkage is held at a low rate. At higher temperatures, weight losses and decay increase markedly. (See Figure 13.)

Cellar Storage

A fair percentage of the tubers were held for about 3½ months in storage in a root cellar. The cellar employed in these studies was used for many other purposes and as a result it was opened frequently during the day. With proper management so as to keep the storage closed on warm days and open on cool nights it would be possible to maintain lower and more agreeable temperatures. Observations indicated that potatoes held up as long as the temperature remained in the low seventies, and that decay became quite rapid when the cellar temperature reached 80 degrees.

Potatoes to be stored should be handled carefully to avoid cutting, bruising and damage to the skins. Only sound potatoes should be placed in the cellar. Those injured by heating in the field, scalded, or infected by rot organisms will not keep in common storage.

Warba potatoes appeared to keep slightly better in common storage than did Triumph.

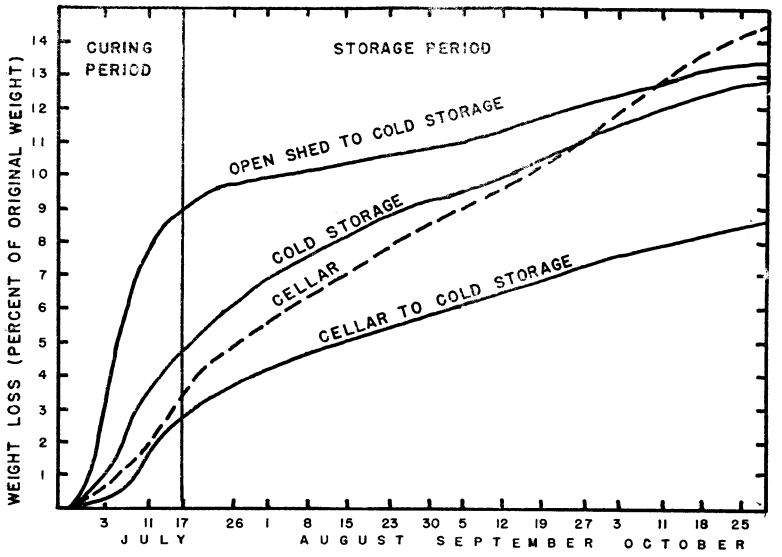

Fig. 13.—Weight losses for several lots of potato tubers in relation to various curing and storage environments. The curing period was terminated July 17, 1938, when some lots were shifted to the storage room.

Refrigerated Storage

In refrigerated storage, potatoes keep well at a temperature of about 50° F. Because the tubers are likely to be immature at harvest time it is recommended that they be cured out 10 days to two weeks in a cellar at a moderate temperature (about 70° F.) and in a moist atmosphere before placing them in refrigerated storage. As shown by Artschwager *(4)*, this curing treatment is essential to heal skinned areas and to thicken the outer covering in order to reduce the rate of shrinkage after the tubers are placed in refrigerated storage. More mature tubers were benefitted less by this pre-storage treatment.

Tubers which were quite severely damaged by the heat in the field shriveled but did not decay while in cold storage.

Ventilation During Storage

Newly harvested potatoes, especially immature ones, require more oxygen or better ventilation than is required later in the storage period, and ventilation is necessary at all times when potatoes are stored at high temperatures.

Fig. 14.—This potato shows blackheart caused by a deficiency of oxygen in a poorly ventilated storage room. Adequate ventilation is especially important for newly harvested spring-grown potatoes placed in common storage, since such potatoes "breathe" quite rapidly.

Experiments in New York *(20)* and California *(5)* have shown that blackheart in stored potatoes (See Figure 14) is caused by a deficiency of oxygen in the storage. Potato tubers, being composed of living tissues, are actively breathing at all times. The maximum rate of respiration is usually found in newly harvested tubers, and the minimum rate at the mid-storage period. Immature or wounded tubers respire more rapidly than mature and sound ones, although, as shown by Appleman and Miller *(3)*, this difference disappears after the immature tubers have been stored for some time.

Shipping Washed Potatoes

The demand for washed potatoes on the northern markets is increasing and some questions have been raised as to the advisability of washing potatoes before shipping them out. It is the opinion of some that washed potatoes will not hold up in shipment unless they are pre-cooled or shipped with refrigeration. Another question is whether the tubers should be packed immediately after washing or given a drying treatment before packing and loading.

Studies by Wright et al. *(22)* indicate that the washing of potatoes prior to shipment increased decay unless the tubers were pre-cooled before shipping or were shipped with refrigeration. Tubers dried after washing were found to lose .25 to .46

pound per bushel. Studies conducted in Kansas *(10)* indicated that pre-cooled potatoes shipped without icing and with standard ventilation were best following washing. Those pre-cooled after washing and iced all the way were too cold on arrival at the destination and sweat considerably on removal from the car.

Observations on pre-cooling potatoes in Louisiana *(19)* indicated that about one and one-half tons of ice were required to pre-cool a car-load of potatoes (reducing the temperature from 74.5 to 57.3° F.). Pre-cooling was accomplished by installing fans on the bunkers to draw the cool air out and to force it throughout the car. These fans with adapters to fit the bunkers were built at a cost of about $33 and their operation aided in drying the potatoes during the loading period. These investigators indicated that the temperature of the load should be reduced to about 55° F. in pre-cooling when the washed potatoes are to be shipped without additional icing and with standard ventilation.

In a one-season test at the Oklahoma station, washing potatoes before they were stored in small lots in half-bushel baskets did not encourage decaying, even when the tubers were packed wet and stored at relatively high temperatures in the root cellar. The tubers in these containers were quite well ventilated and therefore this test probably does not represent exactly the conditions encountered when potatoes are packed in bags and shipped in freight cars where moulding and decay may result not because of the washing but because of unfavorable conditions during transit.

FALL CROP POTATO PRODUCTION

Fall Crop Problems

The fall season with short days and low temperatures is especially favorable to tuber production in potatoes and one might therefore expect greatest production in crops planted to come to maturity at this time. However, there are certain other factors which adversely affect this late crop and yields are usually lower then those secured in the spring planting. Most of the difficulties in growing fall potatoes are encountered early in the life of the crop.

Poor stands of plants frequently result because of high soil temperatures at planting time. Controlled temperature studies at the Oklahoma station *(9)* have shown that temperatures of 90° to 95° F. are quite destructive to potato seed pieces and observations indicate that the temperature of the soil in the field at planting time is frequently in this range. Moisture may be deficient in the soil in July and early August when the fall crop is planted and this may limit the stand of plants and delay the crop. Planting on fallowed land may help overcome lack of moisture. Finally, unseasonable and early frosts may terminate the growing season before the crop has attained full development.

Experience has shown that prompt sprouting of the seed following planting is desirable to secure a good plant stand. This favors year-old seed held over in cold storage or that grown as an early crop in the more southern areas such as Texas and Louisiana. The small tubers graded out of the Oklahoma spring-grown crop are the most convenient and economical supply of seed for planting the fall crop, but these tubers are somewhat dormant and slow to sprout.

Tests have indicated that spring-grown Oklahoma tubers are satisfactory for seed when planted about the first of August and cut into sets shortly before planting. Cut sets were consistently better than whole tubers in these tests. Cutting induces early sprouting, and cut sets are less likely to break down at high temperatures. Storage of spring-grown seed in the cellar proved to be more conducive to early sprouting than storing in refrigerated storage. The less mature tubers from early spring harvests sprouted more slowly than those allowed to attain full maturity before harvesting.

Cultural Practices

Time-of-planting studies indicated that crops started around the first of August as an average were most successful. At this time the spring-grown tubers were sufficiently advanced in the rest period that cutting alone served to stimulate prompt sprouting of the seed. Chemical treatment was found to be unnecessary and even detrimental when applied at this time. The soil moisture supply was generally more favorable at this time and soil temperatures were generally

lower. The soil temperature during the first few days following planting was found to be most critical, and therefore plantings made in conjunction with rainfall and periods of low soil temperature were most successful as regards stands of plants.

Applying straw mulch to newly planted plots or irrigating immediately after planting served to lower the soil temperature and increased the stand for plantings made while high soil temperatures prevailed. Continued irrigation favored rapid development and greater production in the crop in seasons when rainfall was deficient. A moderate to low ridge helps in maintaining lower soil temperatures and aids in conserving moisture.

Varieties

Early sprouting of the seed of varieties such as Triumph and Warba combined with the shorter maturing period make these varieties preferable to the Irish Cobbler for fall planting. The seed of this latter variety has a longer rest period, sprouts more slowly, and after the sprouts are up a longer time is required to mature the crop and hence there is more chance of the crop being caught by early fall frosts.

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