HOW TO GROW and STORE *Potatoes* **FOR THE CHIP INDUSTRY**

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How to Grow and Store Potatoes for the Chip Industry

ARE you taking advantage of the tremendous demand of the potato chip industry for increasing quantities of good processing potatoes? Did you get your share of the 32 million bushels sales that were made to this expanding industry in 1954? Potato chips are made in every state in the country and are distributed and consumed in practically every settlement regardless of size. It is a good steady outlet for potatoes and comprises one-ninth of all potatoes eaten as human food. In recent years it is increasing 3 to 3.5 million bushels annually.

One of the most important duties of a potato chip processor is the selection of his raw materials and of the raw materials which he uses the potato is the most important. Quality of the raw stock varies considerably between varieties and within the variety when grown under different soil and environmental conditions. It also is tremendously affected by temperature during storage and transit. If you, as a grower, understand just what a processor must have and why he must have it and attempt to supply it, you will be in a better position to sell and to bargain for a sale than those who make no attempt to fill these requirements. In many instances, the potatoes which a processor receives are absolutely worthless to him for processing no matter how good they look on the exterior. A processor must be supplied with potatoes that will process into desirable light colored chips and be of relatively low oil content. The yield of chips from the potatoes should be high.

Growing and handling potatoes by routine methods for supplying the fresh market trade may not be the best for the chipping industry. Practically everything a grower does in producing a crop of potatoes has some effect on the quality of chips or yield of chips made from them.

The number one requirement of a potato is that it process into a light color chip. People "eat with their eyes" and since the consumers' choice is predominantly for an attractive golden brown color chip, the processor finds his sales decreasing when he is unable to produce that quality.

Some of the basic factors on which a chipper should make his choice of potatoes are: (1) grade, (2) variety, (3) specific gravity, (4) maturity and (5) the storage conditions preceding purchase. Various cultural factors such as irrigation, fertilizer program, spray program for the control of insects and diseases, methods of vine killing and others will also determine whether or not the potatoes are desirable for chipping. All of these will

be discussed in this article.

(1) **Grade.** The choice of the particular grade of potato varies considerably from processor to processor. It is not the most important thing to be considered in his choice since it concerns largely the exterior appearance of the potato. Most processors are not as critical of the outward appearance of the potato as the housewife is. He is, however, interested in the size of tubers, amount of defects, rots, second growth, growth cracks, greened tubers, hollow heart, etc. They need not be washed. The amount of defects and also the size of tubers determine the loss in peeling and hand trimming. This is important. Some growers consistently buy nothing but U.S. 1 grade, others buy commercial grade and some think that field run potatoes are the best buy. Some may purchase one grade part of the time and another grade for another part of the year depending on price, quality and performance and what appears to be the best bargain. But keep in mind—no matter how good they look on the outside they must make crisp, tasty chips of light golden brown color. If they don't meet this standard they are worth little or nothing to the processor—unless he can't get anything better.

(2) **Variety.** What is desired in a variety?

Above all, it must process into a chip of light color, not only a portion of the year but during the entire storage season. Every slice and all portions of each slice preferably should be of uniform light golden color. Many potatoes will produce chips which are light at the apical end and dark at the basal end. These are undesirable and must be picked out and thrown away or if left in they lower the quality of the product. A potato may boil, bake or mash to a beautiful snow white and yet be worthless to the chipper because it fries too dark. The chemical systems in the potato which result in these discolorations are entirely different in their reaction and, therefore, different treatments are necessary to prevent them.

A variety also should be of high specific gravity so that it will result in a high yield of chips of relatively low oil content. This is very important to the processor and to a great degree it determines the extent of his profits. The higher the specific gravity of potatoes the lower the oil content of the chips. Oily chips are not highly desirable and are costly to produce because of the cost of oil. The chips also should be crisp, of good flavor, no

blistering and with no defects as a result of hollow heart, vascular discoloration, stem end browning, etc..

There is no one variety which meets all of these requirements at all times. Growing conditions and production areas influence these factors so that a variety may perform well at one time of the year but not at another or from one growing area but not from another. So choosing by variety alone is not sufficient. There can be as much difference between the same variety grown under different conditions or in different areas as there is between any two good varieties.

Considering all of these factors the following varieties are recommended for chips when they are grown in the areas to which they are well adapted: Russet Rural, Smooth Rural, Russet Burbank, Irish Cobbler, Kennebec, Sebago, Katahdin and Cherokee. Chippewa produces chips of acceptable color but usually the specific gravity is so low that yield of chips is low and oil content is high. Of the potatoes that are not stored but are processed in the spring and early summer the White Rose from California and Sebagoes from the southern states are acceptable.

(3) **Specific gravity of potatoes.** This is an excellent tool or yardstick to determine the processing quality of the potatoes which the grower has for sale. As mentioned earlier it determines the yield and oil content of the chips and to some degree it also affects chip color. It should be high, indicating that the potatoes are low in water content. Every grower or dealer who is interested in selling to the potato chip trade should have a "potato hydrometer", an instrument which quickly and accurately determines the specific gravity of any lot of potatoes. These instruments are manufactured and sold by the National Potato Chip Institute, 946 Lianna Building, Cleveland 15, Ohio.

The factors which affect specific gravity of potatoes during the growing season will be discussed later in this article.

(4) **Maturity of potatoes.** Maturity is highly desirable in potatoes for chipping. Immature potatoes are of low specific gravity and hence result in low yields of chips with a high oil content. Color of chips from immature potatoes which are stored is likely to be undesirably darker than chips from mature potatoes. Mature potatoes also are more quickly and satisfactorily reconditioned for chip making after storage than are less mature tubers. The chemical composition of mature and immature potatoes are consider-

ably different and in favor of the mature tubers. Immature potatoes such as those harvested in southern California and in the southern states process to a desirable color if they are fried soon after harvest and are not subjected to cool temperatures during transit.

Maturity can be obtained best by planting early as possible, harvesting late and by killing potato vines fairly slowly so that food manufactured in the leaves can be translocated to the tubers. A fairly low nitrogen and potash supply, high phosphorus supply and not too much rainfall or irrigation also will hasten maturity.

Factors affecting maturity, and specific gravity of potatoes and color of potato chips.

Specific gravity of potatoes and color of potato chips depend on the chemical composition of the tubers. The chemical composition is influenced by a number of factors which are discussed below.

(1) **Variety.** This topic has been discussed earlier in this paper. Some varieties, such as Green Mountain, are never used for potato chips because their chemical composition is such that chips made from them always are too dark. Because of this they are not processed although their specific gravity is consistently high. A good choice of a variety would be from one or more of the eight mentioned earlier.

(2) **Soil type.** Type of soil in which potatoes are grown may affect specific gravity of tubers because of its moisture content and consequent temperature. For instance, a sandy soil would be of lower moisture content than a loam or clay loam soil. In a wet season this could be an advantage and result in potatoes of higher specific gravity. In a dry season, however, it may result in lower yields but the potatoes might still be high in specific gravity unless the season was very hot. A soil high in moisture content will usually be several degrees cooler than a similar soil of low moisture content. This cooler soil may result in high specific gravity tubers because less food is lost from the potatoes by respiration.

As a general rule, potatoes grown in muck soil are of lower specific gravity than those grown in mineral soil in the same area.

(3) **Date of planting** is very important in determining specific gravity and maturity of potatoes. Early planting lengthens the season of growth and results in greater maturity at harvest time than from any later planting.

(4) **Date of comeup of plants** is very important since that determines the

time at which the plants start to manufacture their own food. This also affects maturity and specific gravity of the tubers. If the soil is dry or cold after planting, the time of comeup will be delayed and the growing season therefore, shortened. Hence, date of comeup actually is more important than date of planting for determining specific gravity and maturity of the tubers.

(5) **Kind and amount of fertilizer applied** also affects maturity and specific gravity of the tubers. High nitrogen applications result in prolonged growth of the plant and delayed maturity. High potash applications also tend to prolong growth; phosphorus promotes maturity. Hence it is best to apply no more complete fertilizer than is necessary for satisfactory yields.

(6) **Rainfall, irrigation and soil moisture** affect the quality of potatoes for processing. Up to a certain point, of course, these factors are necessary for growth of the potato plant. Usually, however, maturity is promoted and specific gravity is higher when potatoes have been grown in low to medium soil moisture than at high soil moisture. Therefore, it is best not to irrigate too heavily or too late in the season unless temperatures are very high. As mentioned earlier, a dry soil will reach a higher temperature than the same soil when moist and in hot seasons this may result in lower specific gravity tubers because of greater loss of food by respiration.

(8) **Spraying for control of diseases and insects** also has an effect on quality of potatoes for chipping. In most areas it is necessary for the grower to spray or dust with Bordeaux mixture, insoluble coppers or organic fungicides such as Dithane for the control of fungus diseases, especially early blight and late blight. There is no evidence that this procedure is harmful to potato chipping quality except that it delays maturity of the plants. It is a necessary evil as far as potato processing quality is concerned.

For insect control DDT is most extensively used. Because of its successful control of most common foliage insects it prolongs growth, delays maturity and, in most instances, necessitates vine killing. It is recommended that DDT be omitted from the fungicide spray during the last 2 or 3 applications. This may result in more mature potatoes than if DDT applications were made later in the season.

(9) **Killing potato vines.** Before the days of DDT it was not necessary to kill potato vines for table stock potatoes; insect injury did it for us. While the insects were slowly killing the plants there was translocation of manufactured food from the tops of the plant to the tubers. This food

(sugar) was converted to starch resulting in high specific gravity potatoes. When our modern rapid methods of vine killing are employed, there is little or no opportunity of transfer of food from the tops to the tubers. Lower specific gravity and different chemical composition of the tubers result. It is best therefore, to kill potato vines slowly if possible, or to kill them as late as possible. All of our experiments show that specific gravity of tubers was higher from plants killed slowly (such as by chemical sprays) than by rotobearer if both were done on the same date.

(10) **Date of harvest.** In order to get as mature a potato as possible, harvest should be delayed as long as you can without subjecting the potatoes to too low a temperature. Potatoes should not be chilled or allowed to frost in the field before or during digging or in transit to the storage. Undoubtedly some potatoes are ruined for use as chipping potatoes by exposure to temperatures under 40° F. before they reach the storage. It is very important to have a record of the day and night temperatures which prevailed in the field during the last 2 weeks of growth before harvest and during harvesting operations.

Additional Factors of Importance

The grower should know all he can about the following subjects and be able to give the information to the processor so that he can follow it up in the processing plant with performance of the potatoes as chips.

(1) **Were sprout inhibitors applied in the field?**

It is necessary to store potatoes at 40° F. or lower to prevent sprouting. However, storage at these low temperatures results in accumulation of sugars and other chemical changes in the tubers which result in dark colored chips. This necessitates long, costly periods of reconditioning at high temperatures to obtain desirable color. In some seasons and with some varieties and with immature potatoes this sometimes cannot be accomplished at all or within a feasible length of time. It would be desirable to have potatoes treated so that they could be held at 45° to 50° F. or higher for sometime without sprouting or with few short sprouts.

Spray applications with maleic hydrazide (MH 40) to plants in the field late in the season has greatly reduced sprout growth of potatoes when stored subsequently at 50° F. This should be applied usually in August about the time that a few lower leaves start to turn yellow and die. A rate of 7 lbs. MH 40 per acre is recommended. This material costs about \$15.00 per acre. This application should not be made to potatoes which are to be used for

seed for it may keep them from growing even after they are planted. Several other chemicals and methods for preventing sprout growth are available but they are not yet recommended for use because of lack of clearance with the FDA or because of excessive cost or for other reasons.

The grower should keep a record of any sprout inhibitor used, its rate and date of application, etc., so that he can supply this information to the processor.

(2) Prevalence of late blight or other diseases affecting tubers.

Growers should record the dates of spray or dust applications of fungicides and the material which was used. If any blight, etc., is present it should be noted and potatoes from these areas should be stored separately and not be offered for sale to processors.

(3) Potatoes should be handled carefully.

A great amount of damage to potatoes often results during harvesting. An excellent crop can be ruined by bruising, skinning and cutting tubers during digging, picking up, transporting and unloading into storage. Roughly handled tubers result in poorer keeping quality and extra work and loss at the trimming table.

(4) Conditions during transit.

Potatoes should be held between 45° and 75° F. during transit. If held at too low temperature or if iced too much in transit they may result in chips that are too dark. Temperatures above 75° F. for very long periods of time, especially in fairly tight areas may result in blackheart. Ventilation

in cars or trucks during shipment is considered highly desirable.

(5) Conditions during storage.

Farm storages or other storage structures adapted to the storage of potatoes for the fresh market are usually not the best for chip potatoes. Control of temperature and ventilation or air movement is much more important for potatoes to be made into chips. Automatic controls are highly desirable.

The building should be well insulated. There should be exhaust fans in the roof or in the peak of a gable end for good exchange of air.

In general, bins should be smaller than for table stock potatoes, not more than 10 feet wide and the potatoes 10 to 14 feet deep. In order to keep potatoes from being in an area of poor air circulation, it is suggested that the lower part of the bin side walls be tapered toward the center of the bin floor. With air ducts 24" wide and 16" deep in the floor of the center of the bin running from front to back, air movement from the duct up through the pile is assured. Thus the pile is warmed up or cooled off as rapidly as desired and excess moisture is removed. With constantly recirculated air there are no dead air spots nor any temperature stratification in the bins. Air is taken from the ceiling of the room and forced through the duct system below the bin floors. Warm air when needed is best brought in at 70°-80° F. from a heated room adjoining the storage by the use of a thermostat controlling a damper motor. A cooling action thermostat and time clock operate an exhaust air system which brings in outside air

when lower temperatures or an air change is desired. An excellent publication on "White Potato Storages for New Jersey, Long Island and South-eastern Pennsylvania", Marketing Research Report No. 70 may be obtained by writing to United States Department of Agriculture, Agricultural Marketing Service, Washington 25, D. C.

Performance of the potatoes in the processing plant.

The pay off on all the above mentioned information is, of course, the quality of the chips which are made from these potatoes.

The grower, after following the best known methods for producing and handling potatoes for processing should have a good record of how the crop was produced and stored. This information should then be given to the processor so that he can relate this to the quality of chips from these potatoes. If color of chips, for instance, is good in one shipment and unsatisfactory in another, the chances for finding what caused this difference is much greater if the processor has all the information on these two lots as listed above. If he does not have this information and cannot get it from the grower, he may not be able to use this second lot. If he had the necessary records it might be possible to alter storage temperature or some other factor so that the potatoes would be of use to him.

After several seasons of such records as called for above, the processor and the grower will have a better idea which procedures to continue and which to avoid in order to be assured of satisfactory potatoes for chipping.