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## EC1217 Mechanical Injury of Potatoes : Cause and Prevention

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MECHANICAL INJURY OF POTATOES: CAUSE AND PREVENTION

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Injuries at harvest time still constitute the major grade defect in most lots of Nebraska grown potatoes. The tubers of the Triumph variety, as they are grown in western Nebraska, are very tender and must be handled with very great care. During many seasons from 30% to 50% or more of the potatoes of most lots are damaged so they cannot be included in a U. S. #1 grade or they rot in storage. Much or most of such damage can be avoided if the grower will fix his equipment in the proper way and will handle potatoes by methods that have been found to be very effective. Each year for a number of years some growers have been putting their potatoes into the bins with less than 10% mechanical damage. Growers who have a high percentage of sound potatoes can realize good returns if they can market their crops as Nebraska U. S. #1 grade washed Triumph or Nebraska Blue Tag Certified seed potatoes both of which are in great demand at good prices. In this circular we not only analyze the main causes of mechanical injury but describe methods that have been found to be very effective in preventing injury to potatoes. Practically every potato grower can adopt any or all of the practices described.

TYPES OF MECHANICAL INJURY

The principal types of mechanical injury are:-

- a. Cuts due to improper depth or inadequate width of blade.
- b. Bruises from very slight bruises that are hardly noticeable to very severe bruises which may involve the crushing of a considerable part of a potato combined with numerous deep or long cracks. These are generally caused by the digger chain or rough handling in picking or hauling.
- c. Cracking or checking often referred to as air cracks may in a very few cases be due to the dry or cold air but almost invariably these cracks have their origin from some mechanical shock - even though it is often very slight. This is the most common and difficult trouble to be overcome in handling Triumph potatoes in September and October in western Nebraska. The causes leading up to it and some preventive measures are discussed in more detail under a separate heading.
- d. Nicks into tubers that gouge out small areas are common in dry years when clods are numerous. They may cause serious losses if storage conditions are not very satisfactory for wound healing.
- e. Feathering or skinning of the potatoes is commonly not taken seriously but has been found to cause serious losses due to shrivelling and rotting, and of course such potatoes cannot be used when bright red washed potatoes are being sold.



All these types of injury may serve as a source of infection with a rot producing organism and may cause serious losses in storage. They also constitute serious grade defects with a resultant reduction in price to growers.

### Tuber Cracking - Cause and Prevention

Cracking of tubers at harvest time is due to the unusually high turgidity of the tubers, which places the potato tissues under such high tension that they crack when subjected to even a mild physical shock. The severity of the crack depends upon the degree of turgidity of the tuber and severity of the shock. For some reasons not understood, potatoes of the Triumph variety seem to be the most susceptible of all varieties to cracking.

This condition of extreme susceptibility to cracking is brought about in the tubers by anything that causes a more or less sudden reduction in the amount of water given off by the leaves at a time when the roots are still functioning much more actively. Accompanying or following quickly after such a change there appears to be a very great increase in the amount of water absorbed by the tubers without an accompanying increase in the growth of the tubers. This increased turgidity appears to continue until the amount of water absorbed by the roots decreases considerably either due to the loss of water from the soil or the deterioration of the roots as a result of the dying of the tops. Some of the naturally occurring conditions that bring about tuber cracking are:

- a. A sudden increase in the amount of soil moisture late in the season without an increase in temperature or decrease in humidity.
- b. A sudden decrease in temperature or increase in humidity, either or both of which greatly decrease the rate of water loss by the leaves.
- c. A sudden reduction in the leaf area of the plant due to a light frost or an attack of early blight that destroys some of the leaf area. Cutting off part of the vines or killing them with a spray may bring about the same results for a few days but after that a better moisture balance is restored and tubers no longer crack so readily.


When vines are still almost entirely green, tuber cracking is not brought about as readily as when they are partly mature. Tubers on green vines feather or peel quite readily. Tubers produced on stolons that are partly girdled with rhizoctonia lesions seldom crack.

Much cracking of tubers can be prevented by the following methods:

#### 1. Methods to be used in growing the crop or before digging:

- a. Planting earlier so plants and tubers will be more mature at harvest time. (This may not be desirable because of greater risk of damage by insects and diseases, and because of inferior tuber type and color.)
- b. Withholding irrigation water after the early part of September.
- c. Delaying digging till tubers do not crack. Some seasons this may involve delay until a dangerously late date. Much improvement results from a few hot windy days, especially if the soil is not unusually moist.



- d. Delaying digging several hours on very cold mornings - especially if the air temperature is much lower than the soil temperature.
  - e. Cutting roots sometime before digging by cultivating as deep as possible and as close to the plant as permissible without damaging any tubers.
  - f. Cutting off all roots a day or two ahead of digging by running a potato digger without elevator chain through the field. This will cut the roots but leave vines and tubers in place, the latter covered with soil. The green or partly green vines will continue to give off water actually removing a small amount from the tubers, thereby reducing their turgidity. The digger blade should be rounded or square on the end and bent so as to run as flat as possible, thus disturbing the soil less than would a steeply sloping blade. Growers using this method in central Nebraska found it desirable to cut a triangular or circular section out of the back side of the blade in this style  so as to disturb the ground as little as possible. For both cutting roots and digging it has been found better to use wheel trucks on the front of the digger, (at the sides of the ridge,) rather than the roller which has a tendency to pull the vines. It may be possible to accomplish root cutting with blades attached to cultivator bars on tractors. It is also possible that most of the desired results can be secured without cutting all the roots. Some patience and ingenuity may need to be exercised to make this method work perfectly under all conditions. If vines are very large and intertwined it may be necessary to cut them back with rolling cutters to prevent clogging of the machine and yanking some tubers out of the ground. This method has not been used in western Nebraska prior to this season. It was first used in central Nebraska in July where it prevented most of the surface peeling or "feathering" of immature potatoes attached to entirely green vines.
  - g. Vines can be killed by spraying with acid or other substances - but this must be done well in advance of digging as it may actually cause an increase in cracking for a few days or a week after which roots die and tubers become more resistant. The use of acid involves special spray equipment and must be used with caution. Anyone desiring to use this method may secure information about it from the Department of Horticulture.
2. Handling potatoes carefully at harvest time. The methods that are recommended as having been found to be satisfactory are described in the accompanying pages.

## PREVENTION OF HARVEST INJURY TO POTATOES

### Effect of Soil and Cultural Conditions

When the soil contains a large amount of moisture the growing period is prolonged, the tubers are more turgid, the skin more tender and the stolons are likely to be longer. Consequently the tubers are more easily cracked and cut in harvesting than when the soil is dry. On the other hand when grown in a dry soil tubers do not crack as readily because of a slower growth rate and tougher skin, but they are damaged more in digging, receiving many bruises from the clean digger chain or from the hard lumps of dirt which are jostled over the chain with the potatoes.

Excessively moist soils at digging time cannot be prevented by the grower except when they are due to late irrigation. A hard, dry soil at harvest time can be



avoided to some extent by cultivation so as to prevent soil baking and cracking, (which might occur after a pounding rain), by improving the physical conditions of the soil by the addition of organic matter or, if available, by the judicious use of irrigation water.

Some tuber cutting can be eliminated by throwing the dirt slightly toward the rows when cultivating or by throwing up a ridge late in the season so that the wheels of the digger will be a little lower. When the soil is damp, many tubers are cut because the dirt collecting on the digger wheels prevents the digger from running at the proper depth. This is especially the case when the second trip is made through the field to dig the alternate rows that were skipped on the first trip. This difficulty is almost entirely avoided when the digger has rubber wheels.

#### Digging Machine - Adjustment

Blade - square or blunt end permits digger to be run at sufficient depth to avoid cutting. With pointed blade the tip runs unnecessarily deep or the point rides on top of a hard pan preventing proper depth and thus cutting potatoes. Double pointed blades are working satisfactorily but difficulty may be encountered with them if old alfalfa crowns have not decayed completely.

Disks Placed Ahead of Belt - A pair of disks placed just ahead of the digger chain on each side of blade, if set at an angle will move more dirt onto the digger and will bring some potatoes in onto the digger, which might otherwise be crowded out under the wheels or be buried. This is especially important when potatoes set on long stolons far from the plant.

Belt or Chain - Level bed diggers or diggers which do not raise the potatoes far from the ground are necessary for best work.

Width - To handle Triumph potatoes properly the digger belt should be 26 or 28 inches wide and never less than 24 inches.

Length - depends upon steepness. If high wheels are necessary for traction from horse power then long belt is preferable because it is not as steep as a shorter one. In moist soils longer belts are necessary for adequate separation than in dry soils.

Links - should alternate, one high and one low, to prevent rolling of tubers. Belts are available that have the rods covered with rubber. Such protection becomes more important in dry than in damp soil.

Belt should be in one piece to avoid harmful drop onto rear or shaker section (on old diggers this may require installation of special supporting rollers underneath to avoid dragging belt). With a tight belt less injury occurs than when the belt is loose.

Height and slope of belt. The belt should be as low as possible. When power is derived from an engine or by "power takeoff" from tractor, high wheels are not necessary and low wheels should be used. Belts should be as nearly flat as possible from front to rear. Much "feathering" or "skinning" occurs if potatoes roll on belt. Rear end of continuous belt should be as close to the ground as possible. It should be only as high as necessary to prevent dragging when turning. This might be made adjustable and controlled with a lever as is the case with some new model diggers.



Rollers - should be used with belt unless it is absolutely necessary to use shakers to sift dirt through and then as few shakers as possible should be used. Shakers should never be used on any portion of belt that is not carrying dirt.

Deflectors at rear may be desirable to prevent potatoes from rolling out to the side where they will be crushed by the tractor or horses the next trip through. However, they should be well padded and set as wide as possible so they will be hit only by potatoes that would roll out to the side. Somewhat the same result is attained by dragging a small V shaped frame under the digger to provide a smooth soil surface with a ridge on each side or an inverted  $\wedge$  shaped rooflike device fastened under the chain provides a similar smooth surface. This device is not feasible on the new low diggers.

Pad all parts where damage might be done to potatoes. Places which should be padded and methods that can be used are:-

- a. Cover ends of belt links with a strip of engine belting. (Strips 5 or 6 inches wide are satisfactory.)
- b. Pad belt by using rubber covered rods or by covering every other rod with rubber hose. If soil is damp, rods will soon be covered with dirt and this coating of moist dirt may be sufficient protection.
- c. Deflectors at rear should be padded. Burlap (several thicknesses) horse collar paddings and automobile or truck inner tubes or sponge rubber are all satisfactory.

#### Digging Machine - Operation

Depth of digging should be as deep as necessary so as not to cut any potatoes. This may require more horses or a stronger tractor or it may involve making changes in the digger such as cutting off the point of the share. On damp days or when the surface of the soil is moist in the morning because of dew or frost, the depth may be altered by dirt collecting on the wheels, thus raising the entire digger. This is especially likely to occur on the second trip through the field when the iron wheels run over loose damp soil. The ridge thrown up for irrigation renders deep digging quite easy. On dry land a ridge thrown up over the row a short time before digging will give some protection against frost and will facilitate digging.

Speed of Belt should be adjusted according to the condition of the potatoes and soil conditions. For that reason a power transmission or convenient engine adjustment is desirable so that the belt can be operated at any speed independently of the speed of the tractor or horses. Sometimes sprockets may need to be changed to secure proper speed. One of the most common sources of trouble is too great speed with the tractor or the digger belt. A chain speed of 7 R.P.M. or less has been found to give very satisfactory results.

Amount of dirt on the belt: The injury to potatoes by the belt is inversely proportional to the amount of belt that is not covered with dirt. That is, when only one-fourth of the belt is covered with dirt, the damage is much greater than when half or two-thirds of it is covered. The best practice seems to be to have at least three-fourths of the length of the belt covered with dirt. This is controlled by the speed of the belt, the depth of digging, the texture and moisture in the soil and is something which must be watched continuously.



Constant watching and frequent adjustment may be necessary because of constantly changing conditions. A few of these that might well be kept in mind are:-

- a. Changing soil conditions in a field as a result of changes in character of soil such as spots of gravel or clay, or different depth of subsoil or even a hard pan, differences in moisture content also changes in elevation even if only slight. These changes will very likely cause differences in the soil moisture but are also quite certain to cause differences in depth and distance of tuber setting as well as differences in maturity and size of tubers and other characteristics which will render the tubers more or less susceptible to injury.
- b. Change in soil conditions from day to day because of rains or because the surface portion may be getting dried out by warm or dry weather.
- c. Change in soil conditions from morning to noon due to moist surface soil, as a result of dew or frost. This causes dirt to stick to the digger rods, thus in very dry soil, providing more protection than later in the day when the surface dries off, or it may cause dirt to collect on digger wheels raising them and causing more tuber cutting.

#### Potato Picking

Time between digging and picking. Potatoes should be left on top of the ground after digging until the skin dries off and toughens to some extent. Then it will not peel or feather easily and the potatoes will be less likely to bruise or crack. The length of time they are exposed will be governed by the conditions. On warm and sunny or windy days one or two hours may be most practical. Exposure for a longer time may cause excessive weight loss and if the sun is very bright and air very dry, exposed cut surfaces may be damaged so that they will not heal. Such unhealed places permit the entrance of rot producing organisms. There is danger of sun scald damage if the sun is extremely bright, especially if the air temperature is above 80° F. On cool damp days longer exposures will be necessary. Even after exposing the potatoes for some time the lower side of the potato will still be damp unless the ground is very dry. Consequently some portions of each potato will still be tender and likely to feather.

#### Picking Container and Methods

The picking belt to which a sack is attached and dragged on the ground between the legs of the picker, is the most popular picking device at present. The one handling that is eliminated by their use is a big advantage. These belts are especially satisfactory if yields are heavy. If the soil is cloddy immature tubers may be feathered considerably in dragging the partly filled sack over the clods. Pickers should endeavor to avoid jostling sacks, for potatoes will "feather" badly in rubbing against each other. The sacks should be left lying in the field just as they are unhooked from the belt. Only about 30 to 50 pounds should be picked into one sack.

Picking baskets. The sides and part of the bottom of all potato picking baskets should be lined or padded to reduce the shock when potatoes are tossed into them. One or two layers of burlap or rubber from inner tubes generally give adequate protection. Rubber dipped baskets are quite satisfactory when new, unless they give a false sense of insurance against damage of tubers. Their efficiency decreases as they become older and because the rubber becomes hard or breaks away from the wire. Baskets made entirely of rubber - with wire only in the handle - are now available.



Placing potatoes in the baskets. Care should be used in placing the potatoes in the baskets since tender potatoes are likely to crack if they strike either the sides or other potatoes. The pickers should not toss the potatoes into the baskets for a greater distance than is absolutely necessary.

Emptying baskets into sacks. Pickers should stoop over and carefully pour or roll the potatoes from the picking baskets into the sacks. Few potatoes will crack when poured out in that manner but when carelessly dumped from the customary height of three feet or more, many tubers are severely cracked. Only two basketsful should be placed into one sack if the "half sack" method is used.

Use only clean sacks. If the potatoes are to be sold for seed or if some of them are to be used for seed next year, caution must be exercised with regard to the use of old sacks in harvesting the crop or the potatoes may become infected with bacterial ring rot. Second hand sacks of unknown origin should not be used. Likewise sacks from a farm or cellar or from a locality in which ring rot has been found should not be used. The only sacks that can be used with safety are new sacks or sacks that the grower is sure were never used in handling any potatoes in which ring rot occurred.

Standing up the "half sacks". After the potatoes have been poured into the sacks many pickers skin or crack a large number by jarring or jostling the sack to settle the potatoes so that the half-filled sack will stand up easily. With newly dug potatoes one can hear many of these tubers cracking. Much of this jostling is unnecessary and the half-filled sacks can be made to stand up by pulling up with a back-and-forth twisting motion, which will pull the sack tight and cause the potatoes to settle more compactly without causing any skinning, bruising, or cracking. The same precautions should be observed if potatoes are being put into sacks which are filled to capacity and sewed shut at digging time.

#### Handling Potatoes from Field to Storage Cellar

Since there is always danger of damaging tender newly harvested potatoes when they are handled, harvesting operations should be planned with a view to subjecting the potatoes individually or in sacks to no more movements or transfers than are absolutely necessary.

- a. In order to permit the surfaces that were next to the ground to dry off and toughen, the part or half sacks of potatoes may be left in the field for several hours to dry off thoroughly in the sun and wind. This may be risky if the sun is very hot or bright.
- b. Do not jostle the potatoes about in the sack by unnecessary "shaking down". With part sacks left by the picking belt method, pick up the sack with both hands so as to keep it in the position in which it was left in the field.
- c. Hold the sack firmly immediately above the potatoes so that the potatoes will not move around in the sack as the outer skin is easily "feathered" or peeled off. Avoid leaning part sacks of potatoes against the edge of the truck or wagon in loading as that crushes some of the potatoes. In the case of partly filled sacks "tie in" each sack into the load so as to avoid any movement of the load.



d. do not drop the sacks on the floor of the wagon or truck for that causes the crushing of many potatoes in the bottom of the sack. If the first "half sacks" loaded on the wagon or truck are properly placed, the later sacks can be loaded without having to drop or force them into place.

e. Never step or walk on the potatoes during any of the harvesting operations, for even though the potatoes are inside the sacks, damage is done, although it may not be seen easily at the time.

f. Padding the floor of a wagon box or truck bed with straw, old burlap sacks, sheep pelts etc., will protect many of the potatoes from bruising when loading and when the load receives jolts on a rough road.

g. A low wagon or truck, preferably with only a floor (no side boards), will reduce the labor in hauling potatoes, and since sacks of potatoes can be more easily handled with such a wagon, less damage will be done. Friction against the side boards has been found to cause considerable peeling. These side boards are not necessary and can be dispensed with.

h. In some of the eastern potato regions the potato-hauling wagons are equipped with springs. In case of rough roads, this is a wise precaution.

Filling the bins in the cellar is a more important operation than merely dumping out the potatoes. Two men are generally necessary to do a good job, one on the vehicle and one or two in the bin. The following procedure will be found practical in the average farm potato cellar:

a. When picking up and carrying the sack, hold the sack securely so the potatoes cannot move around inside.

b. Carry the sack to the rear of the bin and with the least possible disturbance roll the potatoes out of the sack. Cover the floor of the bin with one layer of potatoes to a depth of about one foot, working from the rear to the front.

c. When ready for the second layer, extend a heavy plank from the front boards of the bin to a strip nailed to the uprights or posts in the rear or to movable iron rod supports suspended from the rafters. This plank should be about 2 or  $2\frac{1}{2}$  feet above the floor of the cellar. The next layer should be carried back and emptied from this plank. As the bin is filled the plank should be raised to successively higher levels. Some growers prefer to pad a plank thickly and then lay it on top of the potatoes. This is satisfactory if the plank is padded sufficiently.

d. Never walk over or stand on the potatoes. Do not drop them or throw them into the bin.

e. Dumping potatoes from the wagon into the front of the bin and allowing them to roll down into the rear as the pile is built up in front is undesirable, because in rolling over each other the potatoes will be badly skinned.

Wooden Boxes, if used properly, are satisfactory for getting the crop from the field into the cellar or for storing. Pickers must, however, be careful in pouring the potatoes into the boxes or many of the potatoes will be cracked. The boxes should also not be filled more than level full to avoid bruising in stacking. The main

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advantage with boxes is that they protect the potatoes from bruising in hauling more than do the sacks. If potatoes are hauled to a cellar on the farm about as rapidly as they are picked up, 200 boxes may be sufficient for a crew of five pickers. In emptying the boxes into the bins the same precautions mentioned with the "half sack" method should be observed. All pieces of wood used in making the boxes should have rounded edges. Only small cracks should be left between boards. Corners should be fixed so that boxes can be staked on top of each other firmly. In some sections where lumber is cheap, potatoes are stored in the cellar in boxes. This is an excellent idea from the standpoint of storage of potatoes, but it also is an efficient method of saving a great deal of labor. This method has been found very good for storing potatoes for a high grade market.

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