

# *Preventing* Potato Bruise Damage



*edited by Michael Thornton & William Bohl*



*College of  
Agriculture*



University of Idaho  
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## Checklist for Reducing Bruise

### *Before Planting*

- Select fields that are best suited for growing potatoes and are free from excessive rocks.
- Avoid tillage practices that create clods that will not break down during the growing season.

### *During the Growing Season*

- Use a balanced fertility program to keep vines green until shortly before vine-kill.

### *Pre-harvest Preparation*

- Train all harvest personnel about bruise prevention. Training videos are available at university extension offices.
- Install padded chains on harvesting and handling equipment, and replace when worn.
- Adjust harvester chain conveyor speed in relation to ground speed to maintain a

full, uniform flow of potatoes on each conveyor. Contact an extension office for information on making these adjustments.

- Install padding on the harvester at points where potatoes may be bruised.
- Adjust digger blade height on harvesters and windrowers so potatoes do not bump into the front of the primary chain.

### *Vine-Kill*

- Kill the vines fourteen to twenty-one days before harvest to allow the skins to properly mature. For blackspot bruise prevention, kill vines before 40 percent of the vines have died.
- Apply a pre-harvest irrigation at least one week before digging to soften clods and rehydrate tubers.

### *Harvesting*

- Harvest potatoes only when tuber pulp temperatures are 45°F to 65°F.
- Keep drops to a minimum.
- Avoid using chain shakers to separate soil and clods on harvesting equipment.
- Keep harvester boom close to the pile on the truck.
- Do not walk on potatoes while putting on the tarp.

### *At the Storage*

- Pile potatoes in a stair-step manner to prevent roll down on the pile face.
- Keep drops to a minimum.
- Maintain high humidity in storage unless drying is required to control rot problems such as late blight or water rot.

## Contents

<b>Types of Bruise</b> .....	<b>1</b>
Skinning .....	1
Blackspot .....	1
Shatter bruise .....	1
Pressure bruise .....	1
<b>Bruise Prevention before Harvest</b> .....	<b>2</b>
Pre-plant .....	2
At planting .....	2
Effect of bruising on seed .....	2
Vine management .....	3
<b>Bruise Prevention at Harvest</b> .....	<b>3</b>
Soil moisture .....	3
Tuber condition .....	3
Maturity .....	3
Hydration .....	4
Temperature .....	4
Harvester operation .....	4
Windrower operation .....	5
Harvester modifications .....	5
Blade .....	5
Conveyor chain .....	5
Rollers .....	6
Primary .....	6
Secondary .....	6
Deviner .....	6
Rear crossover .....	7
Side elevator .....	7
Clod eliminator .....	8
Sorting table .....	8
Boom .....	8
<b>Bruise Prevention in Potato Piling Operations</b> .....	<b>8</b>
Tarping the truck .....	8
Unloading the truck .....	8
Stinger position .....	8
Soil elimination .....	8
Piler .....	9
<b>Reducing Effects of Bruising</b> .....	<b>9</b>
<b>Bruise Prevention in the Warehouse</b> .....	<b>9</b>
Run equipment at capacity .....	10
Reduce drops .....	10
Use cushioning .....	10
Warm potatoes before moving .....	11
<b>Bruise Detection Methods</b> .....	<b>11</b>
Heat method .....	11
Instrumented sphere .....	11
<b>Educate</b> .....	<b>11</b>
<b>Sources of Additional Information</b> .....	<b>12</b>

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Information assembled by members of the National Potato Anti-Bruise Committee of the Potato Association of America

### *Editors*

Michael Thornton  
Manager of Grower Services  
NatureMark Potatoes  
Boise, Idaho

William Bohl  
Extension Educator-Potatoes  
University of Idaho  
Blackfoot, Idaho

### *Contributing Authors*

Gary Franc  
Extension Plant Pathologist  
University of Wyoming  
Laramie, Wyoming

Leigh Morrow  
Agronomist  
McCain Foods  
Faston, Maine

Robert Thornton  
Extension Vegetable Crop Specialist  
Washington State University  
Pullman, Washington

Roger Brook  
Extension Agricultural Engineer  
Michigan State University  
East Lansing, Michigan

Glenn Vogt  
Agricultural Services Manager  
J. R. Simplot Co.  
Caldwell, Idaho

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# Preventing Potato Bruise Damage

edited by  
Michael Thornton & William Bohl

Potato bruising is a serious problem in the potato industry. The effects of bruising are felt by every handler and consumer of potatoes and are a major economic drain on the industry. Potato bruising is estimated to cost the U.S. potato industry at least \$298 million annually. Most of the cost of bruising is eventually passed back to the grower in the form of lower prices, reduced demand, and increased storage losses.

Bruising costs the potato industry because it:

- increases storage losses due to shrinkage and disease
- increases labor costs for trimming and inspecting
- increases the cost of the raw product through greater trim losses
- lowers the quality of the final product
- increases the incidence of disease and decreases shelf life
- reduces the appeal of fresh potatoes to wholesale and retail customers

With bruise-free incentive clauses in processor contracts and an increasing emphasis on limiting external grade defects

in all markets, growers need to develop season-long management plans to prevent bruising. They should be especially aware of four factors that have a major influence on the amount and severity of bruise: (1) soil conditions, (2) tuber condition, (3) equipment maintenance, adjustment, operation and modifications and (4) magnitude of tuber impact.

## Types of Bruise

There are four major types of potato bruise damage: skinning, blackspot bruise, shatter bruise, and pressure bruise (Fig. 1). The first three result from the potato hitting objects, such as equipment, clods, rocks or other tubers during harvesting and handling operations.

**Skinning** or "feathering" often results from handling immature potato tubers, resulting in the skin being scuffed and rubbed off. Tubers with skinned areas that have turned dark as a result of exposure to wind, sunshine, or dry air ("scald") may be unacceptable for the fresh market.

**Blackspot** bruise occurs when the impact of a potato tuber against an object damages cells in the tissue just beneath the skin without actually breaking

the skin. Within 24 to 48 hours the damaged tissue turns dark gray to black in color, but can be seen only after peeling the potato.

**Shatter bruise** results when impacts cause cracks or splits in the potato tuber skin. The cracks may extend into the underlying tissue. Diseases such as Fusarium dry rot, early blight, and bacterial soft rot easily invade tubers that have shatter bruise.

**Pressure bruise** develops in storage, causing a flattened or depressed area on a potato tuber. It usually results from tuber dehydration (water loss) caused by low soil moisture before harvest and/or by inadequate humidification of ventilation air in storage. Potatoes with pressure bruises may not be acceptable for the fresh market.

Recently, another type of bruise called "white knot" has been reported in chipping potatoes. The damage appears similar to blackspot, except the dark coloration is lacking. White-knot bruise tends to form a hard spot when the potatoes are processed. The exact cause of white-knot bruise has not been determined.

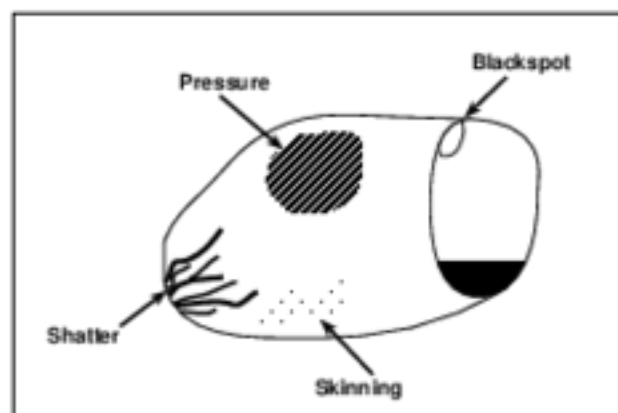


Figure 1. Types of bruise that occur on potatoes.

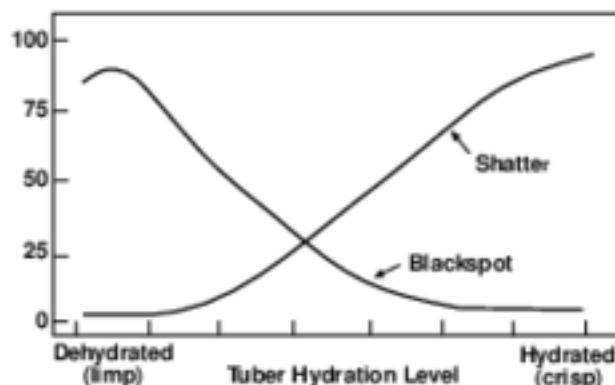


Figure 2. Effect of tuber hydration level on potential blackspot and shatter bruise susceptibility of Russet Burbank potatoes (45° to 50°F). Source: Thornton, R. E., D. A. Smittle, and C. L. Petterson. 1973. *Reducing Potato Damage During Harvest*. EB 646. Washington State University

## Bruise Prevention before Harvest

### Pre-plant

Utilize crop rotations that increase soil organic matter levels to reduce soil crust formation, improve water-holding capacity and keep soil tith the best for bruise reduction. Organic matter will also help improve soil texture, reduce clod formation, and prevent water puddling.

Spring plowing, disking, or cultivating of wet soil results in the formation of clods, particularly in heavy texture soils. These clods persist through harvest and increase the levels of blackspot, shatter bruise, and skinning. If possible, deep rip or chisel plow the previous fall to break up hard pans. Soil freezing and thawing will help soften clods brought to the surface during deep tillage.

Remove stones from the field before planting to help keep rocks from being buried in the potato row at planting. Stone removal after planting helps,

but getting the job done before is more effective.

### At Planting

Timely planting will allow the crop to reach desired maturity before harvest, thus reducing susceptibility to bruising. Avoid excessive nitrogen fertilization, which delays vine maturity and can increase tuber susceptibility to bruising at harvest. Provide adequate fertilization, particularly of potassium and calcium. Deficiency of these nutrients can affect the ability of the tuber to heal wounds and fight disease, and may increase susceptibility to blackspot bruise.

Manage cutting and planting operations to achieve a uniform plant stand. Erratic stands mean more variable tuber size and maturity, resulting in greater bruise susceptibility. Uniform stands result in more uniform tuber flow in the harvester, which results in less bruising.

Set and operate marking out and planter operations to achieve the proper spacing between rows,

especially between guess rows. Use a modified tillage bar behind the planter to break up planter wheel tracks and reduce early-season clods.

### Effect of bruising on seed

Seed tuber and seed piece handling practices can affect performance in several ways. Rough handling increases the potential for decay and physiological aging. Physiological aging results in increased stem numbers, and lower yields. However, the actual impact of bruise damage on seed productivity depends on many factors, including seed quality, variety, and environmental conditions. Therefore, it is difficult to predict how bruising will affect seed performance.

Because of cold handling temperatures and the number of operations associated with seed transport, careful handling by both seed and commercial growers is essential for reducing the level of seed damage. Surveys conducted in Idaho during 1993 and 1994 found

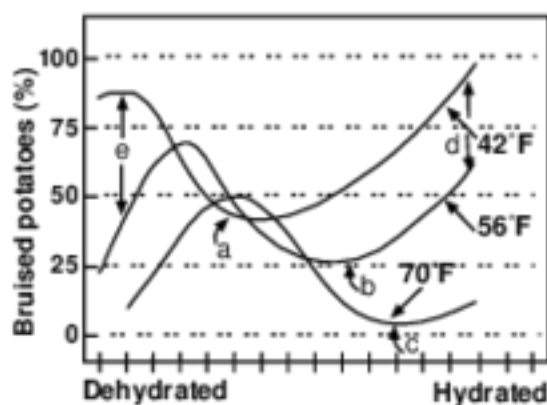


Figure 3. Effect of tuber temperature and hydration level on shatter bruise and black spot bruise susceptibility of Russet Burbank potatoes. Source: Thornton, R. E., D. A. Smittle, and C. L. Petterson. 1973. *Reducing Potato Damage During Harvest*. EB 646. Washington State University

that approximately 50 percent of the bruise damage on seed tubers occurred during harvest; 30 percent occurred during sorting, transport, and receipt by the commercial grower; and the other 20 percent occurred during the cutting operation.

### Vine management

The goal of vine management is to condition tubers in preparation for harvest. To minimize bruising, allow adequate time for tuber skins to toughen. Rate of skin development is not always related to rate of vine desiccation. Skin development will progress slowly under cool or damp soil conditions, even after rapid vine desiccation.

In fields where vine rolling is practiced, tuber damage may occur from contact with stones in the hill. The benefits of vine rolling must be considered on a field-by-field basis. Do not roll vines if there are many sharp stones in the field. Vine beaters must be carefully adjusted to avoid damaging tubers in hills.

## Bruise Prevention at Harvest

An integrated approach is required to maximize the percentage of bruise-free potatoes. This involves harvesting under as nearly ideal temperature and soil moisture conditions as possible, along with matching the volume of material flowing through the harvester to its capacity. Speed of conveyors on the harvester may need adjusting to keep a full volume of material flowing through the harvester.

### Soil moisture

If soil is dry, irrigate lightly before harvest to soften clods so they break apart rather than scrape against tubers in the harvester. Dry, sandy soil will separate too rapidly from tubers on the primary conveyor, reducing the total load (soil and tubers) on the conveyor. Underloading the harvester conveyors increases tuber damage. A light irrigation to moisten the soil can partially overcome problems with excess

soil separation. If irrigation is not an option or is not used, increase the forward speed of the harvester to increase the load of tubers and soil on the primary and secondary conveyors.

Conversely, when soil is too wet at harvest, the total load of soil on the conveyors increases. Excessive soil can be eliminated by using shakers to increase bed agitation, but this increases tuber damage. A better option is to decrease the forward speed of the harvester to reduce the soil load on the primary and secondary conveyors. Soil should be carried to the end of the secondary chains.

### Tuber condition

Three tuber physical conditions affect the susceptibility to bruising at harvest: (1) maturity, (2) hydration (tuber water content) and (3) temperature.

**Maturity**—Immature tubers are very susceptible to skinning and shatter bruise when harvested. Mature tubers can be achieved

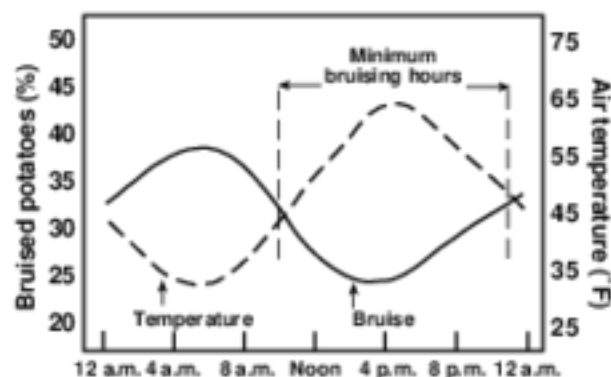


Figure 4. Effect of time of day on potential bruise damage in fall-harvested Russet Burbank potatoes. Source: Thornton, R. E., D. A. Smittle, and C. L. Petterson. 1973. *Reducing Potato Damage During Harvest*. EB 646. Washington State University

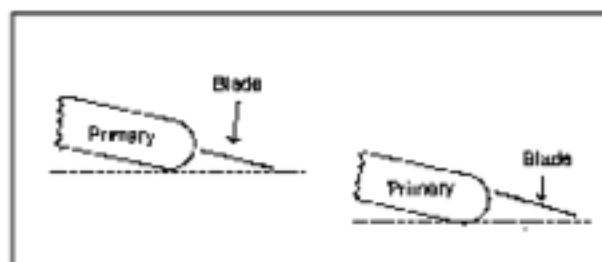


Figure 5. A digger blade angled into the front of the primary conveyor (left) jams tubers into the chain. A blade tangent to the primary (right) causes less bruising.

by delaying harvest up to three weeks after vine kill. The actual time required for tuber maturation and skin set is influenced by environment, cultivar, plant vigor, fertility, and the presence and severity of foliar diseases.

**Hydration**—Soil moisture at vine kill and harvest affects tuber hydration level. Limp (dehydrated) tubers are more susceptible to blackspot. Crisp (hydrated) tubers are usually more susceptible to shatter bruise (Fig. 2). Potatoes harvested at low temperatures bruise less when the tuber hydration level is between limp (dehydrated) and crisp (hydrated) (Fig. 3, point a). When tuber temperature changes, the tuber hydration level resulting in the lowest bruise changes dramatically (Fig. 3, compare points a, b, and c). Rapid changes in tuber hydration can occur when there is an absence of rainfall, or irrigation is discontinued while plants are growing prior to harvest.

Following vine kill, tubers can become dehydrated and very

susceptible to blackspot bruise when soil moisture content falls below 50 percent. Applying a conditioning irrigation prior to harvest can rehydrate tubers. Research in Idaho has shown that on a silt loam soil, irrigation should be applied at least one week before harvest to completely rehydrate tubers and minimize blackspot susceptibility. In regions where rainfall saturates the soil during harvest, tubers can hydrate and become very susceptible to shatter bruise. If necessary, delay harvest until the soil dries sufficiently.

**Temperature**—Generally, as tuber temperature increases, less bruise occurs. This is most dramatic in highly hydrated or dehydrated tubers (Fig. 3, points d and e). Temperatures between 50°F and 60°F are considered to be best for harvesting and handling tubers. Temperatures above 65°F are considered undesirable because of the increased risk of tuber decay in storage.

Tuber temperature and susceptibility to bruising are influenced by the time of day tubers are harvested. In the fall, low early morning soil temperatures result in the highest amount of bruise. In mid-afternoon, higher soil and potato tuber temperatures reduce tuber damage (Fig. 4).

Soil temperatures in individual fields may vary from regional soil temperatures due to soil water and organic matter content, soil texture, slope, aspect, and localized environmental factors. Soil or tuber temperatures in a specific field are important considerations in deciding the best time to harvest potatoes.

### Harvester operation

Harvester evaluations have shown that the most important factor influencing bruising is the ratio of ground speed to conveyor speed (Table 1). These studies have shown that bruising is minimized when conveyors are kept full of potatoes or full of potatoes and other material. Often the harvester



**Table 1. Conveyor speed to ground speed ratios for harvesters and windrowers.** Modified from G. M. Hyde, R. E. Thornton, J. A. Francis, and R. E. Hermanson. 1990. Potato Harvester Chain Speed Adjustment. EB1558. Washington State University.

Yield (cwt/acre) <sup>a</sup>	200	300	400	500	600	700
Conveyor						
Primary, sandy soil	1.0 to 1.2	1.0 to 1.2	1.0 to 1.2	1.0 to 1.2	1.0 to 1.2	1.0 to 1.2
Primary, heavy soil	1.2 to 1.5	1.2 to 1.5	1.2 to 1.5	1.2 to 1.5	1.2 to 1.5	1.2 to 1.5
Secondary <sup>b</sup>	.65	.65	.65	.65	.65	.65
Rear crossover and Side elevator <sup>c</sup>	.30	.40	.50	.50	.60	.70
Boom	.20	.30	.40	.50	.55	.60

<sup>a</sup> Speed should be no slower than 100 feet per minute to avoid back-feeding.

<sup>b</sup> Yield of tubers entering the harvester. When windrowing, add the additional yield to the volume entering the harvester (Ex. A two-row harvester combined with a two-row windrower in a field yielding 300 cwt/acre is picking up the equivalent of 600 cwt/acre).

ground speed is too slow for the conveyor speeds. Increasing ground speed by shifting the tractor transmission to a higher gear can speed up harvest, increase and smooth out the flow of tubers through the harvester, and reduce tuber damage. Individual conveyors are often at the wrong speed relative to the speed of the preceding or following conveyor. Adjust the ratio of the individual conveyors to each other and to the forward speed by changing the conveyor sprockets.

Harvester operators should be taught to reduce bruising by managing the harvester properly. Careless operation of a harvester, such as leaving the boom too high above the pile of potatoes in the truck, can cause significant tuber damage. Monetary incentive programs based on tuber damage level have been successfully used to motivate operators to reduce bruising.

### Windrower operation

Advantages of windrowing potatoes include more efficient use of harvester capacity and an increase in harvesting efficiency (acres per hour) at a lower cost when compared to operation of

an additional harvester. The use of windrowers to increase the flow of material into the harvester can also reduce bruise damage by increasing the volume of tubers on the primary and subsequent conveyors. However, this benefit is sometimes not realized because windrowers are often operated in a manner that increases bruising. Using the same chain speed to ground speed ratios developed for harvesters (Table 1) can reduce bruise damage caused by windrowers.

### Harvester modifications

Harvester equipment modifications can further reduce potato bruise.

**Blade**—Position the blade and primary bed nose cone rollers so that potatoes flow onto the upper surface of the conveyor rather than bumping into the front (Fig. 5). Hinged metal plates or fingers attached to the back of the harvester blade to bridge the gap between the blade and the primary conveyor have been used to accomplish this. If bulldozing and spill-out occurs due to the steep angle of the blade, elevate the front of the blade and lower the front of the harvester to achieve the desired digging depth. In some

cases the proper alignment of the front of the primary and the rear of the blade can be achieved by lowering the nose cone rollers of the primary conveyor.

Blade design needs to be matched to the soil type, soil condition, presence of plant roots (especially alfalfa and weeds), and depth of the tubers. In general, the blade should not be more than 18 inches in length, with 24 degrees as the maximum angle of tilt from horizontal. Improper blade design, a dull blade, or one that is not scouring freely can result in failure of material to move smoothly through the throat of the harvester, which increases the amount of tuber spill-out around the sides of the primary conveyor.

**Conveyor chain**—Belted, hook, and Linderman chains all have advantages and disadvantages. Chain durability can be significantly affected by soil and operating conditions. Belted chains generally cause the least amount of bruise damage, especially on secondary, side elevator, and boom conveyors, where potatoes often suffer injury due to link pinching, rollback, and bouncing. A

disadvantage of belted chains is that they do not eliminate as much soil as a hook chain of the same pitch. A wider pitch belted chain may be required to achieve the desired amount of soil separation.

Use a link pattern of three or four down links and one straight link on all inclined conveyors such as the primary, secondary, side elevator, and boom to help keep potatoes away from the sides of conveyors. The pocket-like configuration of the chain improves tuber flow by reducing the tendency of potatoes to roll back. This is especially important when harvesting round varieties. Using down links instead of flights also minimizes the drop from the back end of one conveyor onto the next conveyor. A mixture of link patterns increases soil-separation capacity, reducing the need to use bed shakers. However, certain mixed-link patterns, particularly one-up and one-down, can greatly increase tuber damage due to link pinching.

Chain links are available with many types of coatings. Most coatings work on a similar principle, with soft materials or air pockets absorbing some of the impact from potatoes as they fall onto the chain. Chain coatings can reduce the capacity to eliminate soil by decreasing the space between links, a factor that should be considered when determining chain pitch. Durability is also an important consideration when determining which chain coating is best suited for a particular operation.

**Rollers**—All rollers on an individual conveyor should be the same diameter, except where variation in roller size is used to lower drop height between conveyors. Roller size and mounting location should be such that humps in the conveyor bed are minimized to prevent tuber rollback. Using small conveyor bed rollers and head shaft sprockets will minimize the height and slope of the conveyor, resulting in reduced drop height and tuber rollback. Replace worn rollers as needed.

**Primary**—On harvesters with split primary conveyor beds, cover the center support bar with padding to reduce impact and move potatoes away from the chain link ends. This modification is especially valuable when a windrower is used in conjunction with the harvester because a larger portion of the tubers flow onto the center of the primary conveyor.

Just enough soil should carry over onto the secondary conveyor to cushion the impact of tubers as they drop from the end of the primary. Whenever possible, the primary conveyor should be operated without shakers engaged. If shakers must be engaged, use hydraulic shakers that can be regulated by the operator from the tractor. Reduce the distance that tubers drop from the primary conveyor onto the secondary conveyor by lowering the discharge end of the primary conveyor.

**Secondary**—A sloped deflector installed on each side of the harvester where tubers are discharged from the primary conveyor onto the secondary conveyor will divert tubers away from the sides of the deviner and secondary conveyers. Cover the center support bar on split bed secondary conveyors with cushioning. Replace this cushioning frequently because it tends to wear out rapidly. Modifying the position of the deviner chain (see Deviner section) causes the links to perform the role of flights. Doing this, along with removing flights from the secondary chain, will further reduce the drop height from the primary conveyor onto the secondary conveyor.

The upper end of the secondary conveyor can be modified to minimize the drop to the rear crossover conveyor (Fig. 6). Using smaller rollers at the discharge end of the secondary conveyor, coupled with lowering the secondary bed or raising the rear crossover conveyor, reduces the drop height onto the rear crossover.

**Deviner**—Bruising frequently occurs on harvesters and windrowers when tubers strike the links of the deviner chain, causing the tubers to bounce or tumble several times before falling onto the secondary conveyor. Cover the deviner chain links with cushioning material. To minimize bouncing, tumbling, and rollback on the secondary conveyor, remove or reposition the first one or two sets of deviner rollers so that the front part of the deviner chain rides on top of the secondary chain. In this position the

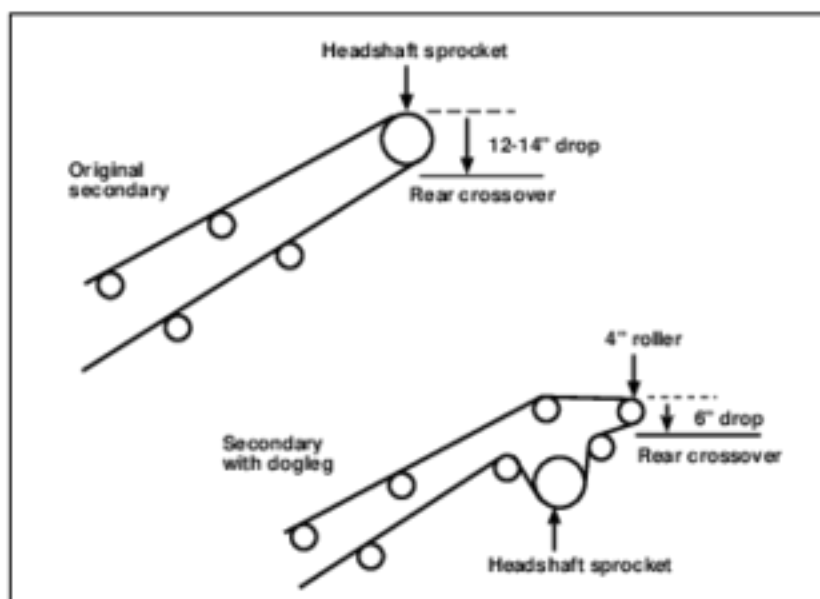


Figure 6. Modification of the secondary conveyor resulting from moving the headshaft sprocket.

deviner links act like flights part way up the secondary conveyor (Fig. 7). Now the flights in the secondary chain can be removed, enabling the drop height from the secondary to the rear crossover to be reduced. A prerequisite to this modification is that the deviner and secondary chains must be moving at the same speed, which may require changing sprockets of the secondary or deviner.

Another option is to eliminate the deviner chain and install a blower between the secondary and the rear crossover to remove vines. Flowing air from the blower can improve the distribution of tubers on the rear crossover.

**Rear crossover**—Because the relatively long drop from the secondary to the rear crossover is combined with a change in tuber flow direction, substantial tuber damage can occur at this transfer point. To reduce bruising,

the rear crossover chain should be covered with a material that provides maximum cushioning.

Another place of injury on many older harvesters is the inside corner where the off-load end of the rear crossover meets the side elevator conveyor. If the load and distribution of tubers are not correct, tubers

often get caught and severely damaged in this corner. The problem can be resolved by installing a padded shield to cover the hole or by extending the rear crossover so the head shaft is aligned with the inside edge of the side elevator conveyor chain.

**Side elevator**—The length and slope of the side elevator conveyor often results in tuber rollback and injury. Flights placed at eight link intervals in the chain can help reduce rollback more effectively than flights placed farther apart. Flights that are stiffer or heavier at the place where they extend over the belted or hooked portion of the chain help reduce rollback of tubers along the side of the conveyor. If the ends of the flight are torn loose or are not stiff enough to carry tubers without rollback, the gap between the edge of the chain and the side of the conveyor bed should be covered or closed by attaching 1 inch x 4 inch wood strips to each side of the conveyor. The lower end of these strips needs to be beveled so that tubers do not get caught

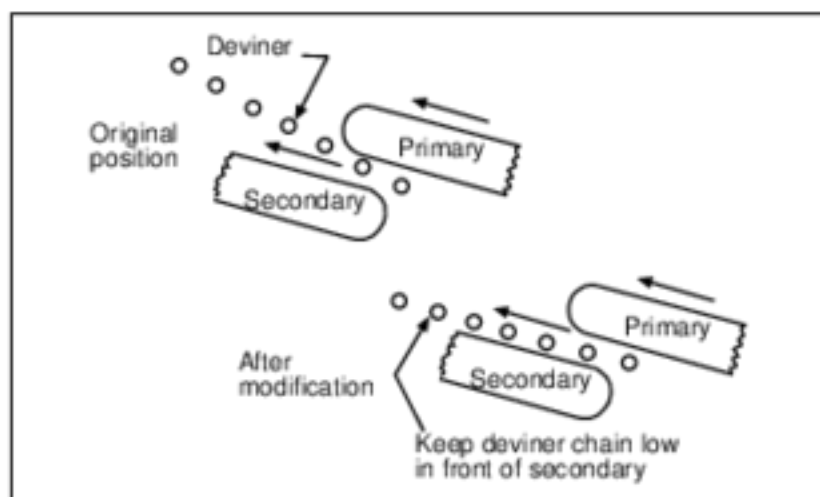


Figure 7. Deviner chain positioning for reduced tuber damage.

against its edge. The wood strip should also be covered with cushioning material.

An alternative is to remove the flights and install a hugger belt. If the volume of material on the side elevator conveyor is unusually heavy, a hugger belt with 3/4-inch risers can minimize tuber movement. Eliminating the flights on the side elevator allows raising the lower end under the discharge end of the rear crossover. Removing the flights on the side elevator conveyor also allows lowering the drop from the top of the side elevator onto the clod eliminator or sorting table.

**Clod eliminator**—All clod eliminator tables are a potential source of injury, particularly to long tuber varieties such as Russet Burbank. Avoid using a clod eliminator table unless the dirt tare penalty exceeds the bruise-free incentive or if there is excessive dirt in the truck.

Regardless of the roller type, tubers can be bruised when they bounce, roll, or tumble while on the clod eliminator table, or when they off-load onto the next conveyor. The amount of bruising depends much more on rotation speed than on roller design. The correct roller speed is one that moves tubers at least the same flow rate as the side elevator conveyor without tuber bouncing. Angling the clod eliminator table slightly down towards the sorting table also aids in the flow of tubers across the table.

**Sorting table**—Tuber injury frequently occurs on the sorting table when the protective

covering along the sides becomes worn. On some harvesters, flanged rollers located near the boom end on each side of the sorting table become exposed when the material covering them wears out. Tubers that catch behind these rollers may start tumbling or be cut by the flange. Replace the covering over these rollers when they show signs of wear.

Some harvesters have metal deflectors attached to the sides of the sorting table to funnel the flow of tubers away from the table edge. Tubers may get caught underneath these deflectors and get pinched, scraped, or cut. The shape and position of these deflectors may need to be modified to eliminate this damage.

**Boom**—Installing a hugger belt (see suggestions for a hugger belt under Side elevator) will reduce tuber rollback on the boom conveyor. If a hugger belt is not used, rollback can be reduced by installing flights with stiff ends every 12 to 16 inches.

The harvester operator must keep the drop from the end of the boom to the tuber pile in the truck as low as possible without the end of the boom touching the pile. This is a very difficult task, especially considering the other demands for the harvester operator's attention. Installing a reliable and accurate electronic boom control device to control automatically the height of the boom conveyor allows the harvester operator to focus on other operating parameters that reduce bruise damage.

## Bruise Prevention in Potato Piling Operations

Successful bruise prevention programs should not focus only on the harvesting operation. A significant amount of bruising injury can occur during truck unloading and piling.

### *Tarping the truck*

Avoid walking on potatoes in the truck while spreading the tarp because this causes substantial tuber damage. If walking on tubers is unavoidable, wearing soft-soled shoes to reduce damage. Mechanical devices for tarping loads eliminate the need to walk on the potatoes.

### *Unloading the truck*

Manage the truck-unloading conveyor to maintain a constant and uniform flow of potatoes onto the receiving equipment. It may be necessary to change the motor pulley size to achieve the desired unloading speed.

### *Stinger position*

Keep the receiving end of the stinger as close as possible to the truck unloading belt. Older stingers may need remodeling, such as repositioning the chain shield or cutting down the edge of the receiving bowl, in order to reduce sufficiently the drop height from the unloading belt to the stinger and from the stinger to the incline elevator of the piler.

### *Soil elimination*

Carrying excess soil and clods into the truck increases fuel costs, and adds to labor and equipment costs at the transloading or storage site.

Ideally, most of the loose soil and small clods should be eliminated on the harvester, with the majority separated from the tubers on the primary chain. Large clods are difficult to separate from tubers without causing bruise damage, and often end up in the load unless manually removed. However, labor shortages, increasing labor costs, and safety and efficiency issues are forcing many potato harvesting operations to search for alternatives to manual sorting at the harvester. Mechanical methods such as roller tables, revolving drum separators, and fluidized sand beds are being used where trucks are unloaded to eliminate soil, clods, and rocks. These methods are effective for removing tare material from potatoes, but they also may contribute to bruising if not properly operated.

### **Piler**

Adjust the piler chain or belt speed so the piler operates at full capacity with an even flow of potatoes, which will reduce the effective drop height at transfer points. Keep the piler boom as close as possible to the

potato pile. A common mistake is to move the boom away from the pile to allow time to accomplish other tasks or to avoid having to give the piler constant attention. Such inattention increases potato damage from longer drops; results in a greater tendency for portions of the pile to slide down; and makes it more difficult to keep the boom continuously close to the top of the pile. Progressive or stepwise piling reduces the amount and distance of rollback and also keeps the top of the pile more uniform (Fig. 8).

### **Reducing Effects of Bruising**

Shatter bruise increases the potential for tuber decay and water loss because the broken skin no longer provides a protective barrier. Proper storage management is critical for rapid wound healing, which reduces the harm from shatter bruise and skinning. Wound healing is improved by oxygen availability, 95 percent or more relative humidity, and temperature between 55° to 60°F. While wound healing is more rapid at

higher temperatures, the rate and amount of decay also increases significantly. Free moisture on tuber surfaces restricts availability of oxygen and slows, or halts, the wound healing process. Wound healing should be completed in 1 to 2 weeks under proper conditions, after which a sprout inhibitor may be applied.

### **Bruise Prevention in the Warehouse**

Grading and packing operations often increase bruise in fresh market potatoes. A high level of bruise may lead to rejection of shipments at their destinations and to lost sales because of dissatisfied customers. Free water inside the bag and inside potato cuts and bruises can increase decay. When potatoes are packed in bags while wet, or when moisture condenses on the inside of bags, bruised potatoes often develop bacterial soft rot.

One way shippers can play a direct role in reducing losses due to bruise is by adjusting equipment and handling operations to minimize tuber injury

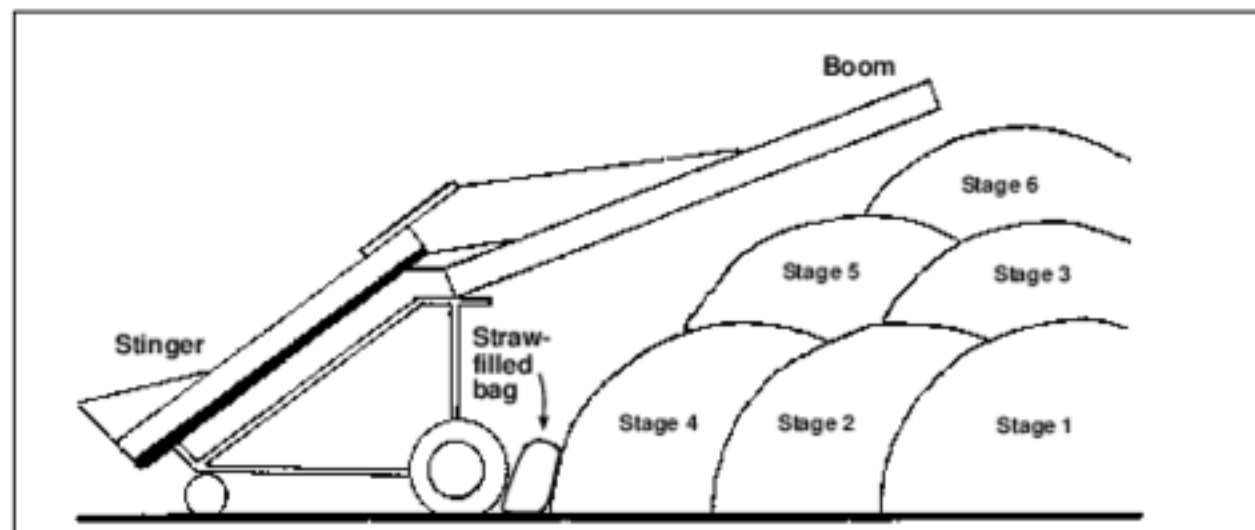


Figure 8. Progressive potato piling procedure.

during packing. Most modifications recommended for packing operations involve simple techniques already used to reduce bruising during harvest. Underloaded equipment, excessive drop height, lack of cushioning, low tuber pulp temperature, and rough handling during pallet stacking and transport loading are all factors that contribute to bruise during packing

### **Run equipment at capacity**

Bruise during the packing operation is often associated with the underloading of conveyor belts, elevator chains, and sizing rollers. A full capacity load of potatoes moving across a drop between pieces of equipment does not experience the full force of that drop because some potatoes cushion the fall for others. Conveyors should be filled to capacity by slowing belt speeds or by increasing volume, and by matching the speeds and capacities of each conveyor to ensure a constant stream of potatoes throughout the packing line. Even-flow bins provide a good way of keeping the volume of potatoes

flowing into the packing line at a constant level. The speed of the rest of the packing equipment can be set at a rate that ensures operation at full capacity when there is a constant flow of potatoes.

### **Reduce drops**

The greater the drop, the larger the bruising force, and the more likely that a bruise will occur. Considerable bruising can occur where drops are greater than 6 inches, especially when the drop area is on belting supported underneath by a hard metal roller or plate. Moving the metal roller or support plate just a few inches to allow potatoes to fall onto an unsupported portion of the belt will reduce bruising. An alternative is to install a padded ramp between conveyors allowing potatoes to slide down to the next conveyor rather than fall the entire distance. A hanging drape made of thin belting strips can be used to slow the speed of the potatoes as they down slide the ramp (Fig. 9).

Steeply inclined conveyors with flights generally cause damage

because of the extra clearance required between flighted conveyors, and the tendency of the flights to throw potatoes onto the next belt. Using shorter flights or hugger belts reduces this problem.

Excessive drop heights are often found where potatoes are loaded into even-flow bins. Reduce bruising in even-flow bins by keeping them full at all times, and using an automatic height sensor on the loading conveyor.

Bruising may also occur at the end of the packing line when workers stack bags or boxes onto pallets. Packaging material provides very little protection for tubers that are dropped more than several inches onto hard wood or concrete surfaces.

### **Use cushioning**

All areas where potatoes strike a hard surface in the packing line should be covered with cushioning material fastened with round-headed, non-protruding fasteners. The cushioning material should be thick enough to absorb the weight of the potato tuber and to prevent

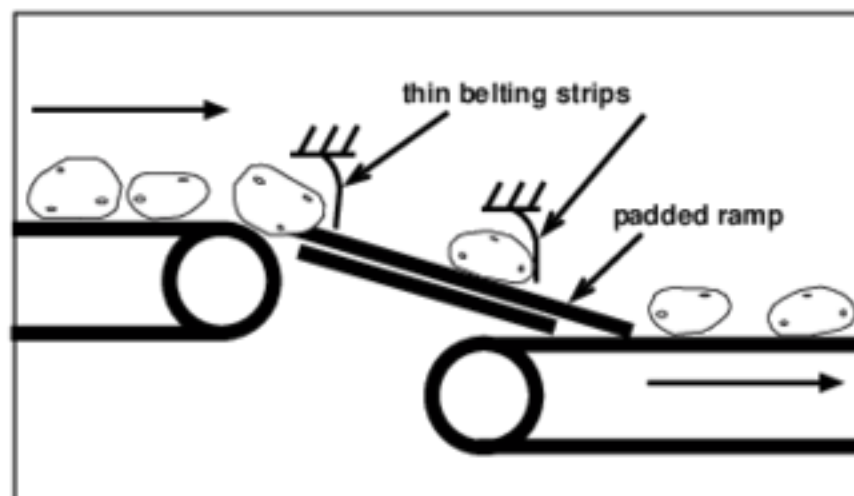


Figure 9. A cushioned ramp reduces the drop between conveyors.

it from striking the hard surface underneath. Closed cell foam materials are recommended because they readily absorb energy and resist moisture uptake. Use cushioning material with a durable surface. Frequently check for wear and replace the material as needed.

### ***Warm potatoes before moving***

Cold potatoes are more susceptible to bruise injury. Because tuber pulp temperatures will typically warm only a few degrees during packing, potatoes coming out of cold storage should be warmed to at least 45°F before being handled.

## **Bruise Detection Methods**

To identify harvesting or handling equipment that is causing tuber injury or to isolate problem locations on individual pieces of equipment, it is essential to measure and monitor tuber bruise damage. There is no standard guideline for the number or size of samples that should be taken, but the more often measurements are made and the larger the sample size, the more accurate the results.

### ***Heat method***

Since the development of the dark pigment in blackspot bruise is a chemical process, increased temperatures will speed up the rate of development. For example, blackspot normally takes 48 hours to develop at room temperature, but takes only 6 to 12 hours at an air temperature of 90°F. By the time blackspot develops in the 48-hour test, conditions could have changed. Therefore, testing at higher temperatures is preferred. An alternate method is to soak potatoes in 140°F water for 10 minutes. Tubers can then be peeled and evaluated for blackspot after six hours.

### ***Instrumented sphere***

Tuber injury is usually caused by potatoes striking a hard surface. Impacts occurring as potatoes are harvested and handled can be measured with a device called the instrumented sphere (IS). The IS, developed by USDA researchers at Michigan State University, contains electronic equipment that measures and records acceleration data during impacts. The stored data is then downloaded

into software on a personal computer that provides charting and data comparisons with damage thresholds that have been developed in the laboratory. Damage thresholds are very dependent on variety, tuber temperature, drop height, and impact surface.

## **Educate**

Preventing potato bruising is the responsibility of everyone in the potato industry. Potatoes may be bruised any time they are handled, and even growing conditions may affect susceptibility to bruise damage. All people involved with growing, harvesting, packaging, or shipping potatoes should be educated about their role in minimizing bruising. Producers, packers, and shippers should train employees about what they can do to minimize potato bruise damage.

This publication on preventing potato bruise damage, along with other educational materials such as bulletins and videos available from your university, can be used to train employees about handling potatoes to minimize damage.

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## Sources of Additional Information

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### **University of Idaho Publications**

BUL 804, "Fresh-Pack Potatoes, Handling, Packaging, and Transportation in Refrigerated Railcars"

*Potato Vine Killing*, CIS 759. 50¢

*Potato Harvesting and Handling Operations for Quality, Efficiency and Safety*, CIS 835. 50¢

Videotape, "Potato Bruise Prevention:  
#1 The Harvester"

Videotape, "Potato Bruise Prevention:  
#2 Harvester Chain Adjustment"

Videotape "Potato Bruise Prevention:  
#3 Handling"

Videotape, "Potato Bruise Prevention  
#4 In Fresh Pack Warehouses"  
*(Order videos for \$29.95 each  
or \$99.95 for the set of four, available in  
both English and Spanish versions)*

UI publications can be obtained from Agricultural Publications, University of Idaho, Moscow, ID 83844-2240; TEL 208 885-7982; FAX 208 885-4648; email [cking@uidaho.edu](mailto:cking@uidaho.edu); website <http://info.ag.uidaho.edu>. Videos are available from Ag and Extension Education, Video/Distance Ed Unit, University of Idaho, Moscow, ID 83844-2329; Tel (208) 885-7985; Fax (208) 885-5029.

### **Washington State University Publications**

EB 646, "Reducing Potato Damage During Harvest"

EB 1080, "Reducing Potato Harvesting Bruise"

EB 1558, "Potato Harvester Chain Speed Adjustment"

WSU publications are available from Bulletin Office, Washington State University, Pullman, WA 99164-5912; (509) 335-2857

### **University of Maine Publications**

Bulletin 2160, "Prevent Potato Bruising During Harvest"

Bulletin 2149, "Potato Bin Piler Selection to Operation"

Bulletin 2414, "How to Calibrate Air Harvesters for Maine Conditions"

UM publications are available from State Publications Office, 111 Libby Hall, University of Maine, Orono, ME 04469, (204) 581-3189.

Potato Bruising - How and Why Emphasizing Black Spot Bruise."  
Running Water Publishing, 523 Oakdale Dr.  
Haslett, MI. 48840

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