NebGuide

Nebraska Extension

Research-Based Information That You Can Use

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Potato Tuber Wound Healing

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The potato tuber has been cut or bruised during harvest. Or, the seed tuber is cut into pieces for planting. What happens to the bruise or cut surface? This publication outlines the steps of wound healing, the factors that affect it, and the importance of sealing the wound.

Healing potato tuber wounds is critical for several reasons, including the potential to negatively impact marketability and yield. An unhealed cut or bruise allows the entry of pathogens that cause diseases such as wet rots (see NebGuide G2203, *Wet Rots of Potato in Storage*). Shrinkage of tubers in storage can occur due to water loss. Poor tuber appearance may reduce sales in the fresh potato market, and product yields of potato chips and french fries may be lowered.

When a tuber is cut into seed-pieces, a major wound is formed. This large break in the skin provides a wide-open portal for pathogens to enter and break down potato tissue. To protect itself from these pathogens, a tuber undergoes wound healing. Unhealed seed-pieces often result in low emergence of seedlings, poor stands, weak plants, and reduced yield and quality. The two periods when tubers are most susceptible to skin breakage are harvest and piling, and seed cutting (see NebGuide G2271, *Bruises of Potato Tubers)*. Therefore, it is after these periods that wound healing is most critical.

Process of Wound Healing

Wound healing is accomplished by a series of four distinct steps: breakage, cross-linking, deposition, and layer formation.

1. Breakage

A break such as a cut occurs through the skin barrier. This results in a layer of broken and collapsed cells at the surface *(Figure 1)* and opens an area through which disease-causing pathogens can enter. Below this layer are large, rectangular storage cells containing starch that are called the parenchyma. Between these cells are spaces (intercellular space), which contain nutrients, proteins, and hormones carried by water. When a break in the skin occurs, this intercellular fluid leaks out, resulting in water loss (shrinkage).

2. Cross-Linking

Depending on conditions in the first several hours, two complex polymers, lignin and pectin, are produced and

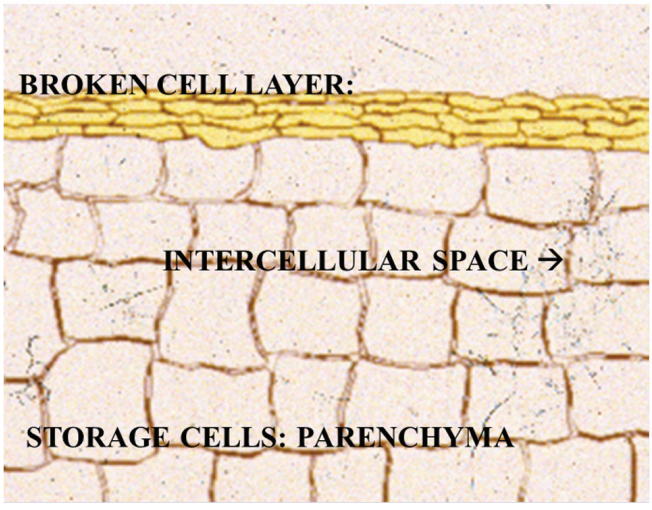

Figure 1. Breakage.

form cross-links in the intercellular space as a temporary barrier *(Figure 2)*. These cross-links form between the outermost layers of parenchyma cells below the break. Under good conditions and at room temperature (65 to 70° F), this process takes less than eight hours.

3. Deposition

Next, suberin, a hydrophobic waxy material, is deposited in the cell walls of these parenchyma cells, and forms a waxy, protective layer called the suberized layer *(Figure 3)*. The suberization of these cells inhibits water loss from the tuber and fungal infection. Under good conditions and at room temperatures, this process can take no more than a day, but under cooler temperatures such as 50° F, it can take up to two weeks.

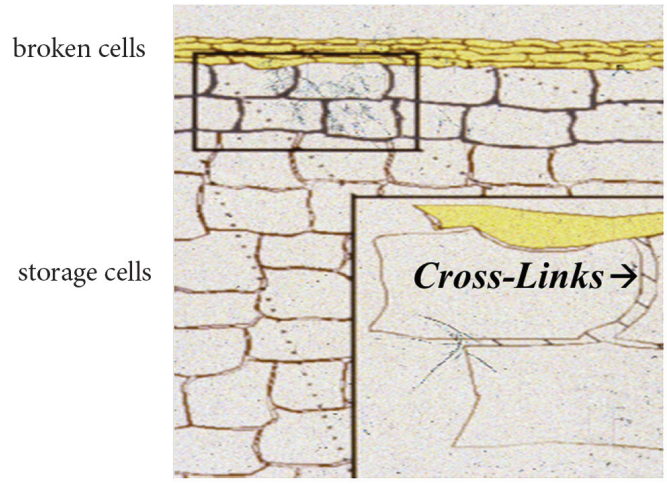

Figure 2. Cross-Linking.

4. Layering

The last process in wound healing is the formation of the phellogen layer *(Figure 4)*. This corky layer of long, rectangular cells forms just below the suberized layer, the phellum. This process takes several days to several weeks, depending on the temperature. At room temperatures, it may take three to five days under good conditions but it can take more than two weeks at 50° F and several weeks if temperatures are even colder.

Together these layers form the new skin or periderm of the tuber. Under optimal conditions, i.e., warm temperatures, high relative humidity, and good ventilation, the whole process takes a week. The periderm then allows control of movement between the inside of the tuber and its environment.

To summarize, a healed cut consists of an outer surface of collapsed cells below which is an area of suberized cells, then some corky cells and a layer of new cells forming a new barrier or the phellogen layer *(Figure 5)*. Together, the broken cells, suberized cells, and the phellogen layer comprise the periderm or new tuber skin. The storage parenchyma cells are below this new skin.

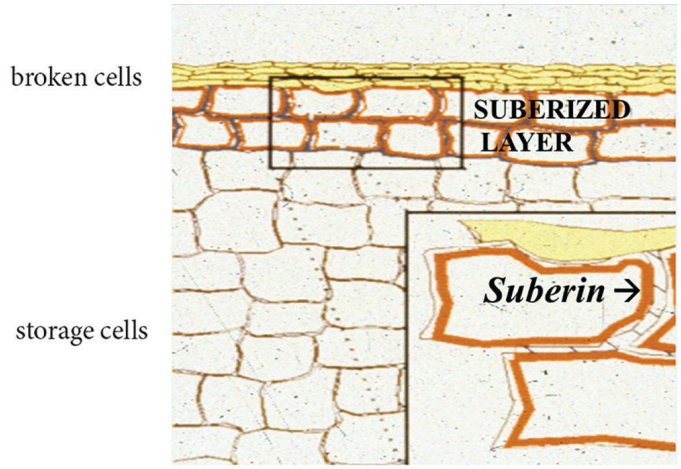

Figure 3. Deposition.

Factors Affecting Wound Healing

How can wound healing be promoted and what will delay it? Some potato varieties heal faster than others, and some varieties form a thicker protective layer than others. The physiological age of the tuber also affects the extent of the healing; younger tubers heal better than older tubers. The three most important and controllable factors are temperature, relative humidity, and aeration.

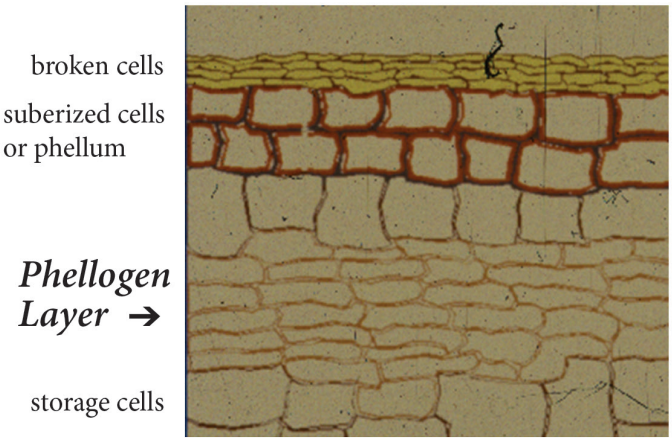

Figure 4. Layering.

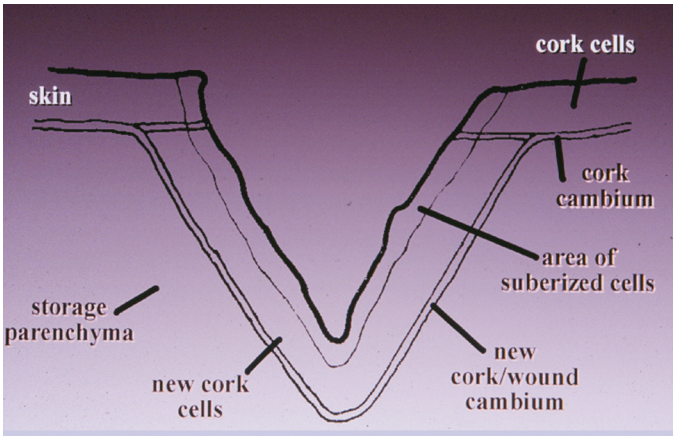

Figure 5. Healed Cut.

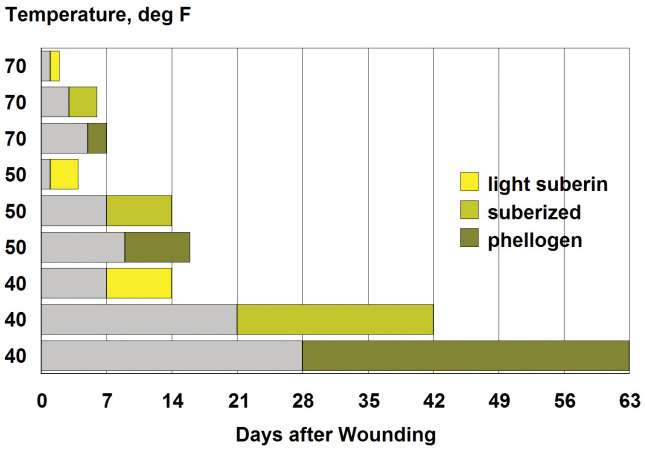

Figure 6. Time for wound healing as affected by temperature.

Temperature

The most critical factor that promotes healing is temperature. As temperature increases, the speed that suberin formation and wound healing is completed increases; that is, it takes less time for the cut to heal *(Figure 6)*. So, if the seed-pieces remain at the temperature that the seed tubers were stored, it could take as long as nine weeks to heal. However, if warmed to room temperature, this would take no more than one week if relative humidity is high and air ventilation is good. Note that higher temperatures also will promote microbial growth.

Relative Humidity

The next key factor is relative humidity. At 50° F, higher humidity promotes suberin formation and periderm or skin thickening. Healing at 93 percent relative humidity has a distinct advantage over 70 percent. But at 68° F (room temperature), that distinction disappears. Healing at humidity above 95 percent becomes inhibitory as cell proliferation may occur in addition to the danger of the condensation on the cut surface blocking gas exchange.

Air Quality

The two key components of air are oxygen and carbon dioxide; too little oxygen and too much carbon dioxide delays cell activity. Wound healing, which requires metabolism, is best when the air contains at least 10 percent oxygen and preferably less than 1 percent carbon dioxide. To promote proper, rapid, and healthy healing, the air around seed-pieces must be well ventilated.

Wound Healing After Harvest

After tubers are harvested, it is best to assume and expect that some bruising occurred during the harvest and piling operation. The initial storage period should be a curing period used for healing the wounds of the harvested tubers. Curing is a short storage period after harvest and before tubers enter the holding period, which is the normal storage for the desired market.

RECOMMENDATIONS FOR CURING:

- Plan for one to three weeks of storage for wound healing.
- Keep storage temperatures near 60° F during this period. If the temperature is lower, the wound healing process slows, and if the temperature is higher, pathogen populations may increase and rots may occur.
- Keep relative humidity between 90 and 95 percent; lower or higher humidity will slow wound healing.
- Ventilation should allow air movement at 10 to 30 cfm/2,000 pounds.
- Do not allow any free water, condensate, wash, etc. Free water blocks oxygen intake, stopping healing and promoting rots.

After the curing period, the storage temperature can be altered to the desired holding temperature. Temperature changes should be fairly rapid, about 0.5° F per day. The holding temperature depends on the market for the tubers.

- For seed tuber storage, the holding temperature is low, between 34 and 38° F unless the tubers need to leave storage early and overcome dormancy.
- Fresh market potatoes are stored at temperatures nearly as cold as for seed tuber storage, between 36 and 40° F. They may be stored slightly higher and longer if a sprout inhibitor is used.
- Tubers being processed as french fries may be stored at 44 to 48° F; sprout inhibition practices are required.
- For most chip processing cultivars, the holding temperature remains in the region of curing, 50 to 55° F, and sprout inhibition is required. Note that for chipping, growers may expose tubers to higher temperatures between 55 and 65° F for a short period, called conditioning or preconditioning, to lower the reduction of sugars in the tubers. This replaces the curing period.

Wound Healing Before Planting

Cutting whole potato tubers and using the pieces for seed (seed-pieces) is a common practice. To achieve high yields, most harvested tubers weigh more than 6 ounces. This is a key reason to cut them into seed-pieces of 2 to 2.5 ounces. Another key reason is to overcome apical dominance exerted by the apical eye or sprout. A major problem with cutting, however, is that it opens a severe and large wound through the skin, allowing some key pathogens to get into the seed-piece. Because of this concern, seed-pieces must be allowed to heal their cut side.

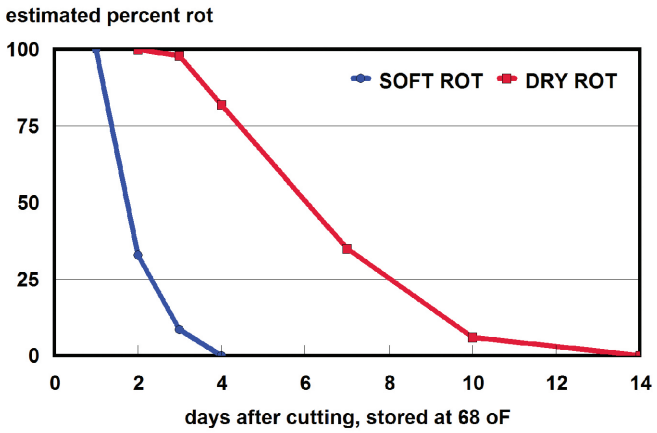

Figure 7. Rotting tubers over time after cutting and inoculating with pathogens (modified from Nolte et al., 1987).

Do seed-pieces perform better when healed in storage before planting? Studies have repeatedly shown that seed-pieces that were healed for two weeks at 60° F out yielded seed-pieces that were cut the same day as planted. Plants from healed seed-pieces emerged sooner, had a higher stand, and grew healthier.

Allow two weeks for the healing process before planting—one week minimum. Timing is critical. The percentage of seed-pieces with either dry rot or soft rot after being cut and exposed to the respective pathogen differ, depending on the time after cutting *(Figure 7)*. After four days, the suberin layer is sufficient to prevent soft rot while two weeks is needed to prevent dry rot on the seed-pieces. Planting directly into the soil will slow wound healing and increase rot.

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