Skin Set, Wound Healing and How to Achieve Both

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Skin Set

As we get into the final stages of growing a potato crop, a number of season-ending activities come to mind. Things like vine kill and skin set. We all know that "skin set" is important but what exactly is this process and what can we do to ensure that it occurs properly and in a timely fashion?

In spite of its below-ground growth habit, the potato tuber is a stem, not a root and, as such, has a number of features that are associated with stems. With this in mind, the "skin" or periderm of the potato tuber very much resembles the bark on the stem (trunk) of a tree. Like the bark of a tree, the periderm is a tough coating that protects from moisture loss and from invasion by diseases, insects, and other pests.

When you think about it, the periderm of a potato tuber has an extremely difficult job to do. It must somehow provide protection and continue to do so during the entire tuber bulking process – a process characterized by dramatic increases in tuber size on a daily basis. You might look at the process of periderm formation as a race between the expanding tuber and the continuing development of the periderm coat to keep the ever increasing surface area of the tuber covered and protected.

To accomplish this challenging task, the periderm must be in a state of constant growth until the tuber itself stops growing. A by-product of this requirement for constant growth is that the periderm is not tightly bound to the underlying tissues so it is very easy to "slip" the skin off an immature tuber. The slippage occurs in a specific region of the immature periderm, which we will discuss in a moment, but first let's take a more in-depth look at the process of periderm formation.

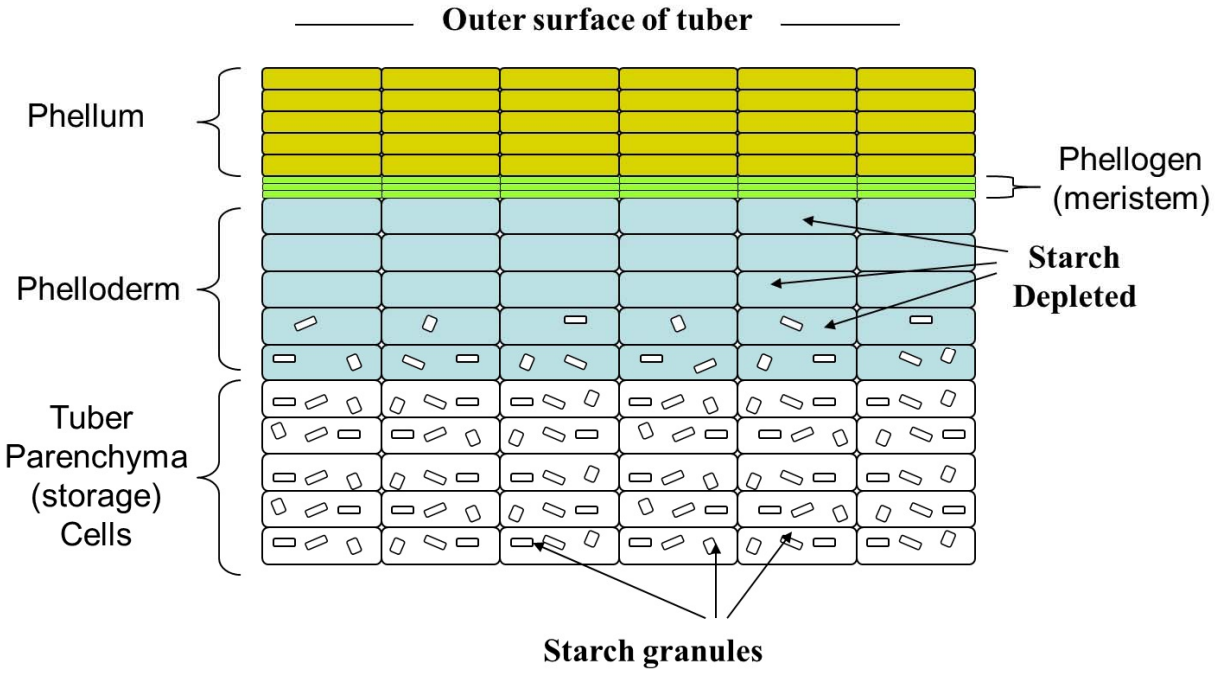
Figure 1 represents a cross sectional view of developing periderm. There are three important zones in this diagram. The green zone is a meristematic region called the "phellogen." The tissues within a plant where rapid cell division is taking place are called "meristems."

Outward of the phellogen are 5 to 6 tiers of "phellum" cells (the yellow zone) that were produced by the phellogen meristem. The structure of the phellum layer is sometimes described as resembling a "brick wall," because it consists of a series of flattened, brick-shaped cells stacked on top of one another. Unlike a brick wall, the cell layers are not offset like alternating courses of bricks would be.

Inward from the phellogen is the "phelloderm" region which provides the energy and biochemical building materials for the growth process. The cells in the phelloderm region generally lack starch granules because the granules have been sacrificed to provide the energy needed for periderm formation.

When the skin on an immature tuber "slips" due to mechanical pressure, it is because the walls of the cells in the phellogen meristem (green) area are very soft and easily damaged. The same characteristic that allows the periderm to continue expanding like an inflating balloon as the tuber grows also makes the periderm very vulnerable to slip damage.

Figure 1. Periderm Formation



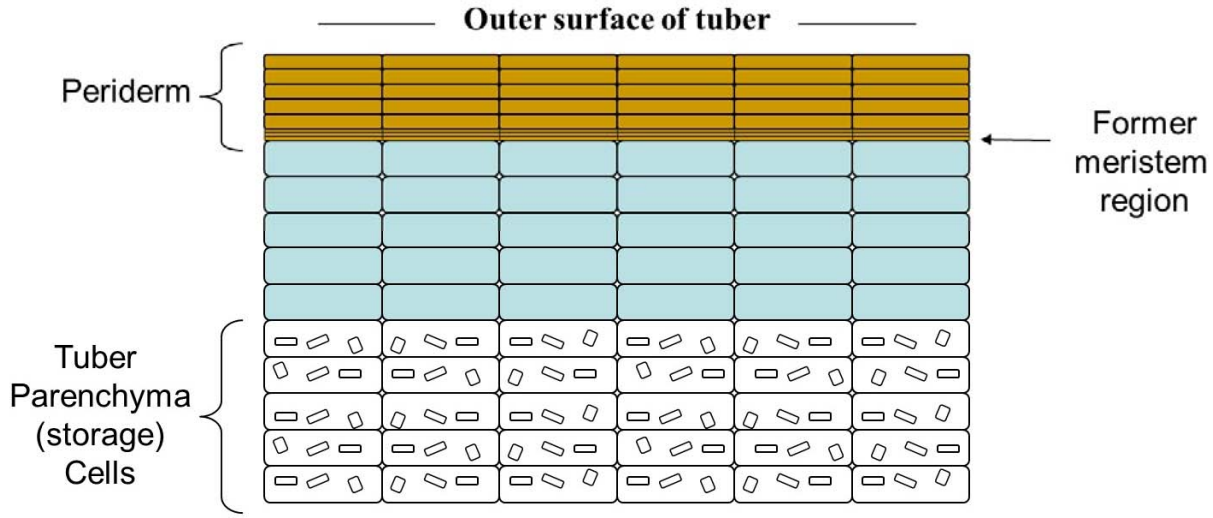
Phellogen layer produces the cells of the phellum layer. Starch depleted in the phelloderm area. Phellogen cell walls soft and easily damaged.

When the tuber finally stops growing, due to vine death and/or other factors, the "skin set" process is initiated. The meristem stops producing new cells, the cell walls harden off, and everything from the former meristem area to the outside (the entire phellum region) becomes heavily suberized. During this process, the periderm becomes tightly bound to the underlying tissues and is then very resistant to mechanical damage (Figure 2). Like the bark of a tree, the now mature phellum cells are no longer alive.

So now that we know how skin set occurs, what can be done to promote it? The major factors that contribute to final skin set include variety, soil type, cultural and environmental conditions, vine maturity and duration from vine kill to harvest. Varieties differ in their rate of skin set. This is primarily a function of genetics but also late season bulking rates and how the variety responds to the conditions in the field. Smooth-skinned varieties, such as a red potato, do not set a skin as rapidly as Russet Burbank.

Since the tuber needs to essentially be no longer bulking or expanding for skin set to begin, it is best to avoid real green vines into the later part of the season. Nitrogen should not be applied past the middle of August in Idaho in order to promote a healthy skin set. Vines should be dead for 10 to 21 days prior to harvest depending upon vine maturity or "greenness" at the time of vine kill and variety. But beware, the longer potatoes sit in the ground after vine kill, the greater the risk for black scurf (rhizoctonia) and silver scurf development. Some varieties, such as Ranger Russet, store well even with a limited duration from vine kill.

Figure2. Mature Periderm



Periderm and former meristem regions now heavily suberized, dried down and tightly bound to the underlying cell layers.

Soil conditions, both temperature and moisture, can influence periderm maturation. Available soil moisture should be managed for 60 to 65% at vine kill to promote skin set. Cool and wet soil conditions can delay maturation whereas warmer soil temperatures increase the number of cell layers and thickness of the periderm. Warmer soil temperatures are often not a luxury late into the harvest season.

Proper skin set needs to be in balance with desired yield, weather, and market end-use of the potato. Proper skin set for stored potatoes is very important when you consider an immature potato has 10 to 60 times greater weight loss compared to a mature potato. The implications for weight loss, bruise potential, and disease susceptibility need to be carefully considered when managing for skin set.

Wound Healing

Wound healing is a process very similar to skin set although it is not identical. Wounds are important because they provide an easily exploited entry point for storage diseases and because time and energy are required to heal them. Many of you have heard of the term “suberization” when referring to wound healing. Suberization is one of the early events in the potato tuber wound healing process which actually consists of several steps.

When a tuber is wounded, healing begins in the undamaged cells just beneath the wounded area. The first event is the deposition of phenolic compounds into the walls of the outer two or three layers of intact cells beneath the wound. One of these phenolic substances is called “suberin” and is the origin of the term “suberization.” Suberin is a complex fat-based phenolic material whose complete structure is as yet unknown. It is easy enough to visualize, however, as

common bottle cork is made up of about 70% suberin. This suberin layer provides protection from bacterial pathogens, such as bacterial soft rot, and seals off the wound to prevent the loss of moisture (Figure 3).

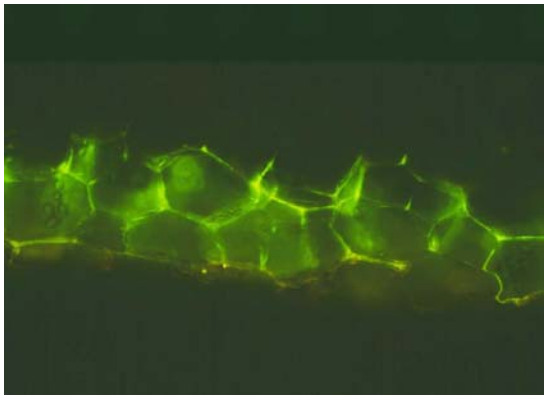


Figure 3. Photo of the suberin layer.

The final stage of wound healing involves the formation of a new wound cork or "phellum" layer. This process occurs within the cells just beneath the new suberin layer, where a series of new cross walls are laid down, parallel to the wounded surface. The area where this occurs is a new meristem and is called the "phellogen," the same as is the case with skin set. After a series of cell divisions, the end result is a layer of flattened, brick-shaped cells which is usually four to six cells deep (Figure 4). When the cell division phase ends, these wound cork cells also become suberized. The temporary suberin layer collapses because its cells are cut off from the moisture supply within the tuber and cannot maintain turgidity. This new wound barrier created by the tuber is very similar to the original skin or periderm of the potato tuber both in appearance and in ability to protect the healed area.

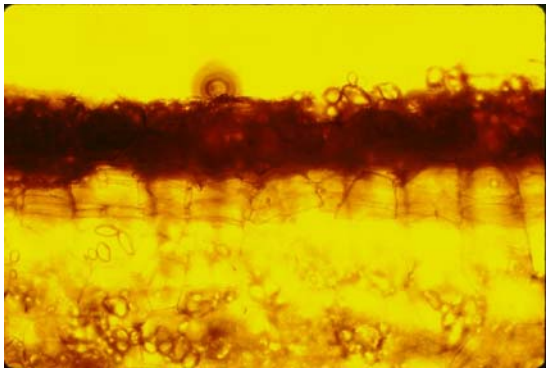


Figure 4. Wound periderm.

The wound healing process takes anywhere from a week to two weeks or even more, depending on conditions. Suberization usually takes two to four days while wound cork formation can take place in as little as a week under ideal conditions but usually takes somewhat longer. Wound healing also requires temperatures of 50 F or higher, oxygen, and high relative humidity. We usually place an upper limit of 55-60 F on wound healing temperatures to favor the potato tuber over the pathogens. Wound healing rates are actually quite high at temps of say 70 F or higher but the activity of most tuber pathogens is so accelerated at these temperatures that the wound healing system cannot react rapidly enough to prevent infection.

This wound healing process is what we are trying to enhance during the "curing period" that is recommended for the first two to three weeks after potatoes are placed in storage. Wound healing must also take place after we have subjected potato tubers to seed cutting, which may be

most serious damage that they are ever likely to suffer. Because of the time required for healing, we often recommend seed piece treatment fungicides to protect cut seed until the wound barriers can be established.

As you can readily see, wound healing in the potato tuber is a complex process that takes long enough that many tuber pathogens can get established before the wounded tuber is protected. This is one more reason to manage harvesting and handling equipment in a manner that keeps tuber wounding to an absolute minimum.

Important Differences

The barriers that result from the processes of skin set and wound healing are very similar to one another but there are some important differences. Areas on the surface of the tuber where wound healing has occurred will be brown, no matter what the original skin color of the tuber was, and they will also be devoid of any complex texture. In other words, wound periderm contains no pigments and will not duplicate the desired surface patterns and textures of a russet-skinned potato.