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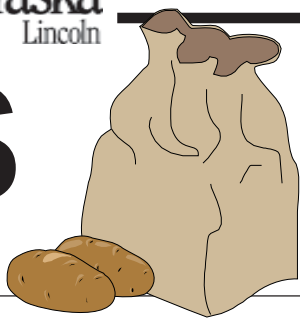
POTATO EYES



Vol. 17, Issue 2, Summer 2005 • Alexander D. Pavlista, Ph.D., Extension Potato Specialist
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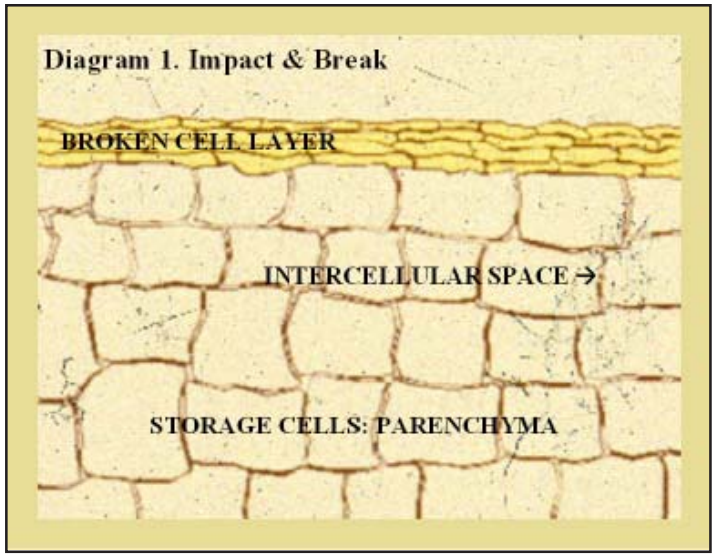
Processes of Wound Healing

In the last issue of NPE, factors affecting wound healing were presented and the importance of wound healing were also discussed. Wound healing is accomplished by a series of distinct processes that will be described here for a better understanding of what wound healing consists.

First, a break such as a cut occurs through the skin barrier. This results in a layer of broken and collapsed cells at the surface (Diagram 1) and opens an area through which pathogens causing diseases such as soft rot can enter. Below this layer are storage cells that contain starch and are called the parenchyma, large rectangular cells. Between these cells are spaces (intercellular space) which contain water carrying nutrients, proteins and hormones. When a break in the skin occurs, this intercellular fluid leaks out, resulting in water loss (shrinkage) from the tuber.

Depending on conditions, in the first several hours, lignin and pectin are produced and form cross-links in the intercellular space as a temporary barrier (Diagram 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. Formation of the cross-links inhibits the entry of bacteria and the occurrence of soft rot (Nolte et al., 1987).



The next process is the deposition of suberin in the cell walls of these parenchyma cells forming a suberized layer (Diagram 3). The suberization of these cells inhibits the water loss from the tuber and inhibits fungal infection such as dry rot

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Why Should Potato Growers Be Concerned About Soybean Rust?

Soybean rust (*Phakospora pachyrhizi*) was first observed in the United States last fall. This sparked intense concern among soybean growers because for them this is analogous to late blight in potato. The pathogen has over-wintered in Florida on kudzu and has already appeared in Georgia, heading from the southeast to the Plains States. University of Nebraska plant pathologists have warned that there is a good possibility that soybean rust will appear in the State this year.

First, the pathogen causing soybean rust does NOT infect potato; potato does NOT get soybean rust. So, why should potato growers be concerned! If soybean rust becomes invasive and appears in soybean fields, an intense management program will be triggered by soybean growers. And, here is the problem. Many of the fungicides used on soybean rust are also used by potato growers to control early and late blights. These include the mancozebs (e.g., Manzate and Dithane), the chlorothalonils (e.g., Bravo and Echo), the strobilurins (e.g., Amistar and Headline), and metiram (Polyram).

For supplies, it is one thing to treat 25,000 acres of potato in Nebraska and another to treat five million acres of soybean in Nebraska alone. And, to make matters worst in Nebraska, soybean rust also is thought to infect dry beans, so Panhandle growers should have concerns as well. So, potato growers be warned, if you do not secure your fungicide needs for the season, you may not have what you need at a sufficient supply at the right time.

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Processes of Wound Healing

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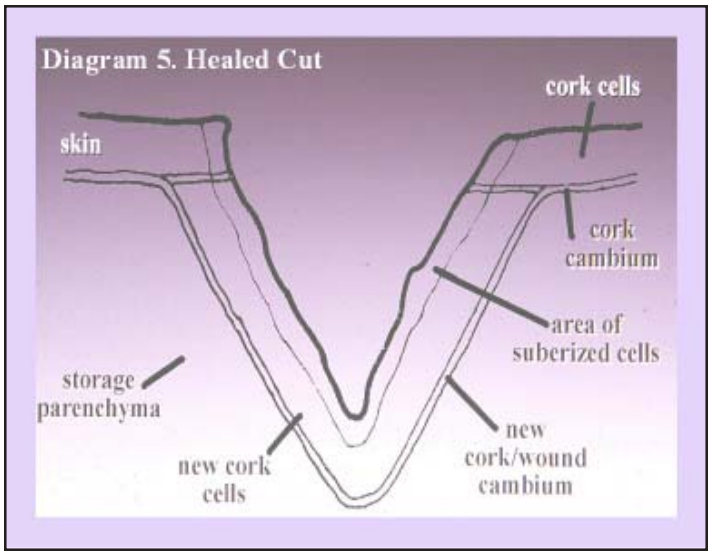
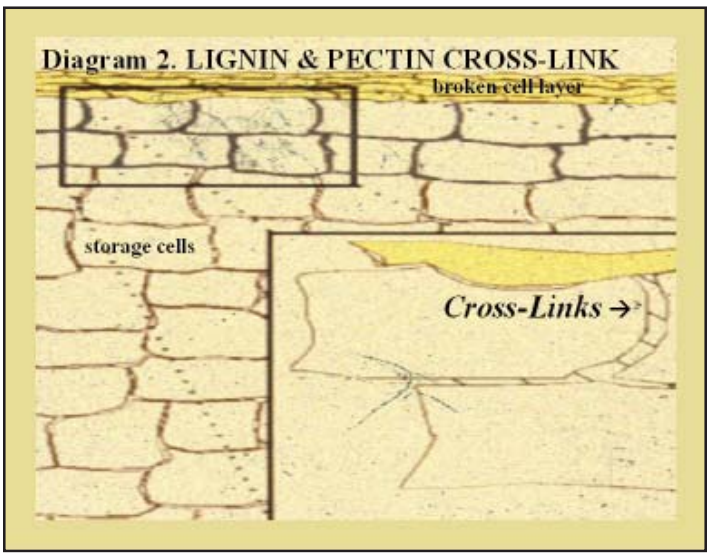
(Nolte et al., 1987). Under good conditions and at room temperatures, this process can take no more than a day but under cool temperatures such as 50 F, it can up to two weeks.

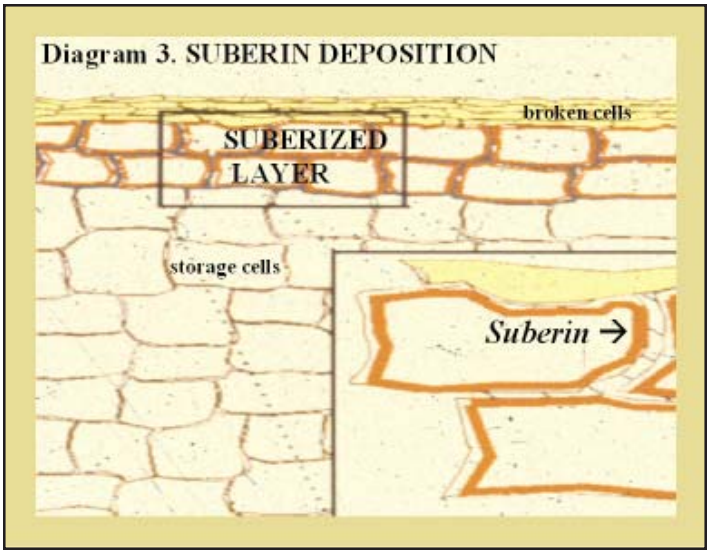
The last process in wound healing is the formation of the phellogen layer (Diagram 4). This layer of long, rectangular cells occurs from cell division of the parenchyma cells just below the suberized parenchyma cells (the phellum) or suberized layer. This process takes several days to several weeks depending on temperature and at room temperatures may take three to five days under good conditions but can take over two weeks under 50 F and several weeks at even colder temperatures (Wiggington, 1974).

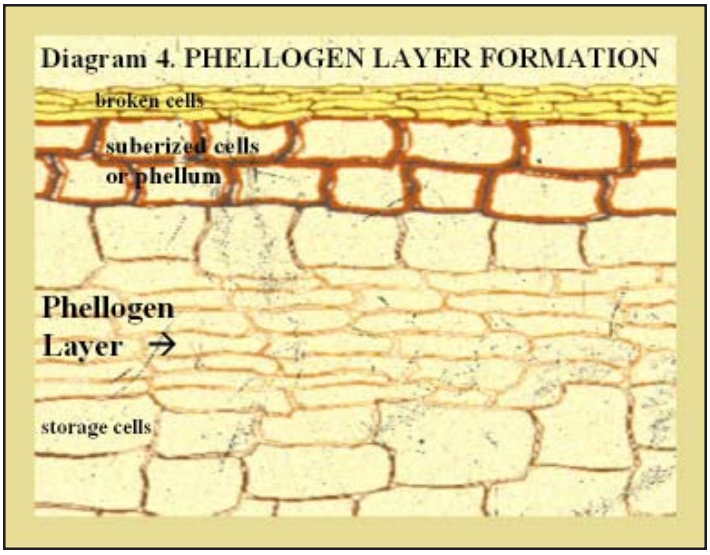
Together these layers form the new skin or periderm of the tuber. Under optimal conditions, the whole process takes a week. The periderm then allows control of movement between the inside of the tuber and its environment. It is clear that temperature and relative humidity are major factors affecting the speed of wound healing (Widdington, 1974); see Nebraska Potato Eyes v.17 i.1, Figures 5 and 6). It is important to note that as temperature increases, there is also a promotion of microbial growth and that if relative humidity is too high (>97%), cell proliferation at the surface can occur as well as growth of anaerobic bacteria such as those causing soft rot.

To summarize (Diagram 5), a healed cut would consist 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. This comprises the periderm or new skin. Below this new skin lies the storage parenchyma cells. For more detailed cellular description of the three layers of the periderm refer to Reeves et al., 1964, and for a cellular analysis of the difference between normal periderm and wound periderm, refer to









External Bruises: Types and Causes

Wound healing occurs when the skin or native periderm is broken or disrupted. The most common disruption is external bruising, of which there are three types -- slicing, skinning and shattering. Bruising affects all potato markets. Disease entry and shrinkage have been mentioned in previous articles in this series. But in processing there is also a reduction in product yield from peeling, and blemishes reduce marketability as fresh produce. So part of understanding of wound healing is to discuss external bruising.

Cuts (Picture 1) result from sharp objects going into or through the potato tubers. Depending on the sharpness of the object, this results in a clean slice through the native periderm with little if any tearing. The most traumatic occurrence of cuts is during seed-piece preparation and was covered in the last issue of Nebraska Potato Eyes. During harvest, cuts occur primarily during the digging and lifting process. Obviously, one wants the blade of the digger to be below the tubers and does not want sharp edges stick out into the flow of potatoes.

A very common type of bruising is skinning (Picture 2), which involves a tearing of the periderm resulting from impacts with blunt objects or sides of harvest and piling equipment. Skinned areas turn dark after a short time, making tuber appearance unacceptable. And, as mentioned earlier, pathogens can enter through these abrasions and water can be lost from the tuber as well. This type of abrasion (scrapes, rubs, scuffs), sometimes called feathering, has been the principle focus in understanding the wound healing process at the tissue and cellular level (Lulai, 2002). Cultivars differ in these characteristics (Lulai and Orr, 1993). The principle factor affecting skinning, besides collisions, is the maturity of the tuber at harvest. This relates to both susceptibility to skinning (that is their level of skin set) and to their ability to heal the abrasion (Lulai and Freeman, 2001). Skinning is a result of poor adherence of the skin to the parenchyma cells below it, and therefore the higher shear strength of the skin, the less likelihood of skinning. Tuber maturation and skin set are directly related to time after vine death. Chemical or mechanical vine desiccation will start the process of skin set, resulting in greater resistance to skin shear and to skinning (Pavlista, 2002).

The third type of external bruise is shatter, which is the splitting of the skin caused by hard impacts such as drops, greater than six inches, during the moving and piling operation. Shatter bruise appears as small cracks radiating from the point of impact and can also be caused be some tuber diseases such as ring rot (Picture 3). Over-hydrated tubers, often harvested from wet soils, are especially susceptible to shatter; skin shattering is directly proportional to tuber hydration. Harvesting and handling tubers below 50 F allow tubers to shattered more easily. Tubers with high specific gravity or greater dry matter content also seem to be more susceptible to shatter. Potato tubers with this bruise are

Causes of Wounds and Bruises

Cut/Slice

Opening of the skinng by sharp, hard impact, causing a deep wound. Seed cutting

Skinning

Abrasion of the skin by scrapces, rubs and scuffs, and is related to tuber maturity (degree of skinn set).

Shatter

Splitting of the skin by hard impacts, causing small cracks radiating from point of impact.

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Web site:

Potato Education Guides. http//www.panhandle.unl.edu/potato

The Nebraska Potato Eyes

is on the World Wide Web at:

www.panhandle.unl.edu/peyes.htm