Harvest goal: maximize bruise-free potatoes
By Nora Olsen and Mike Thornton

Harvesting a quality crop is an important topic on everybody’s mind for the upcoming season. One major quality requirement in all marketing channels is to minimize the incidence of blackspot bruise. There are two components involved in blackspot bruise formation: a physical impact, followed by a chemical reaction that causes the discoloration.

There are many factors that determine how tuber tissue responds to an impact. These factors include things like tuber temperature and hydration, both of which influence cell wall elasticity. Tuber size and shape also greatly influence the impact force from a given drop (large tubers with pointed ends experience more impact force in a smaller area of tissue, increasing the likelihood of cell damage). Plant maturity (percent dead vines at time of vine kill) has also been shown to greatly influence the extent of tissue darkening following an impact. In general, blackspot bruise tends to be highest under conditions of very mature tubers, dehydrated (limp) tubers, and high specific gravity. Certain varieties are also much more susceptible to development of blackspot bruise than others.

A blackspot bruise will not occur without a physical impact. Physical impacts and mechanical injury are inevitable during the harvest and handling process, but a lot of things can be done to minimize the severity of these impacts. A survey by Kleinschmidt and Thornton in 1991 showed that approximately 70% of all mechanical injury occurred as tubers moved through the harvester. The remaining injuries occurred during loading of the truck (14%), transfer onto the bin piler (14%) and with rollback on the pile (2%).

This information emphasizes the need to reduce drop heights and add cushioning on all equipment that handles potatoes. Calibrating harvester chain and conveyor speeds so that they are always loaded with tubers is also extremely important. University of Idaho has worksheets available to help with calibration and timing of your harvesters and can be found at:
http://www.cals.uidaho.edu/potato/Research&Extension/Topic/Harvest/PotatoHarvestManagement-06.pdf

The potential for blackspot bruise formation for fresh potatoes does not stop at the storage building but continues on into the packing shed. Research in the Netherlands showed 79% of all impacts occurred during packaging and only 11% at harvest and 10% during transport. In addition, tubers stored for several months may be more dehydrated than freshly harvested potatoes. Therefore potatoes may be more likely to bruise when removed from storage.

What is interesting about blackspot bruise formation is that the skin is not physically broken. Instead, the cell membranes within the impacted tissue of the tuber are damaged or broken. The damaged membranes cause chemicals to come in contact with each other that are normally compartmentalized away from one another. Polyphenol oxidase (an
enzyme) comes in contact with phenols, primarily tyrosine (an amino acid), and eventually results in the formation of a pigment called melanin that gives the black/blue discoloration. It typically takes about 24 to 48 hours for the pigment to develop. In some instances this biochemical reaction does not occur even if the tissue is damaged. For example, figure 1 shows a Ranger Russet potato that was impacted with the same amount of force on both the stem and bud end. The stem end developed lots of melanin, resulting in formation of a dark bruise. The bud end damage resulted in a white spot of damaged tissue, but little melanin formation. Why the difference between the bud and stem end even though the same amount of force was applied? It may be due to the physical differences between the ends, maturity and/or availability or levels of enzymes and amino acids to react and oxidize. This complex interaction between impact forces, chemical reactions and tuber physical properties provides insight as to why potato bruising may be more prevalent in certain fields, varieties or seasons.

Monitoring bruise incidence throughout your harvest system is a useful way to determine whether bruise susceptibility is higher for a particular lot or field. Taking tuber samples at different points throughout the harvest and handling process (eg. hand dug, harvester, conveyors, any drop points or turns, etc.) and holding them at warm temperatures will allow you to assess the tubers for blackspot damage. The higher the temperature, the quicker the pigment formation will occur and the sooner the results will be available. There are “hot boxes” commercially available for purchase, or rooms can be constructed for this same purpose. The use of an instrumented sphere is another way to determine where unacceptable impacts are occurring in harvest, handling or packaging systems. Additional research is currently being done on the use of free radical generation and oxidative potential as a way to predict bruise susceptibility. The ability to assess the potential for blackspot bruise development would greatly benefit bruise management at harvest.
Figure 1. Artificially bruised ‘Ranger Russet’ potatoes. The same pendulum impact was given to both the stem and bud ends of the tuber. Note the difference between stem and bud end.