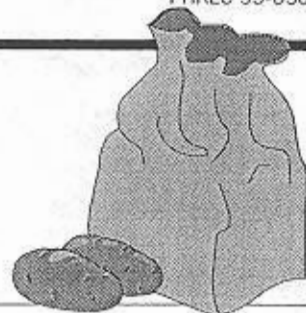


POTATO EYES



Vol. 11, Issue 4, Aug-Sept 1999 • Alexander D. Pavlista, Extension Potato Specialist

Registration Updates

- Chlorine dioxide's (Purogene and Anthium) Section 18 for Nebraska has been submitted to the EPA. Approval is expected and use would begin on September 15.

- Baythroid 2EC (Bayer), a broad-spectrum insecticide, has received full registration (Section 3). It is labeled at 1.6-2.8 fl.oz./acre for CPB, ECB, flea beetle, and psyllids, and at 0.8-1.6 fl.oz./acre for leafhopper. It can be applied by ground, air or sprinkler. Eight applications are maximum and at least five day intervals. There's no PHI.

- SuperTin (Griffin) received a label change allowing application up to seven days before harvest. This replaces Nebraska's Section 24(c).

- Admire/Gaicho (Bayer) mixed with Tops MZ (Gustafson) is being tested under a Section 24(c) in Minnesota and Wisconsin. This is a seed treatment with insecticide as well as fungicide activity.

- Fulfill (Novartis) did not get approval on its Section 18s from Washington and Wisconsin by the EPA under grounds that there are other products. Full registration (Section 3) is still pending.

- Ridomil Gold (Novartis) as an in-furrow application had Section 18s submitted by several States. All did not get approval because of no data concerning environmental impact.

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Check out the Nebraska Potato Eyes
online: <http://www.ianr.unl.edu/ianr/phrec/Peyes.htm>

Physiological Tuber Disorders

As fall harvest approaches, it would be good to review internal physiological disorders of tubers that may be encountered. These disorders are defined as not having a pathogenic or chemical cause. Several disorders will be reviewed, all related to tuber growth and seen in the state through the years.

BROWN CENTER/HOLLOW HEART

Brown center and hollow heart are two facets of the same disorder but can occur independently of each other. Exact causes are not known. This disorder is mostly associated with excessively rapid tuber growth after a cool temperature and moisture stress. An association of stem-end hollow heart with potassium deficiency has also been reported.

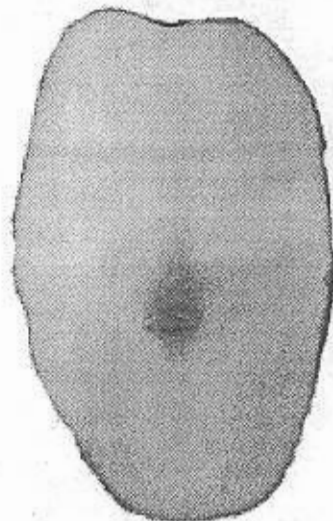
External Appearance: There is no outer way to detect it.

Diagnostic Method: Cut longitudinally from end to end.

Internal Appearance: Brown center is characterized as a small one-eighth to one inch diameter, brown, circular or elliptical, opaque area with a diffuse border along the longitudinal tuber axis. In round to oval tubers, its usually at the tubers center; with long or oblong tubers, there may be two brown areas, one at each end. Brown areas are distinct but have a smooth, gradual change to unaffected tissue. Depending on the speed of growth resumption after stress, brown center may or may not develop into hollow heart. Hollow heart appears as a lens- or star-shaped, irregular cavity in the center of round tubers such as Atlantic or at either or both stem and bud ends of long tubers such as Russet Norkotah. The internal walls are white to tan. The cavity is larger with larger tubers and is mostly seen in very large tubers. No rot is associated with the disorder.

Cooking Appearance: Brown center will boil and fry dark, and hollow heart will leave a cavity after boiling or baking, a hole after chipping, and shorter fries after cutting. US Grade A for table stock potatoes allows for up to dime-size cavities.

Development: Brown center is initiated in small tubers from initiation to two ounces. Cool soil temperature, <56°F, and high soil moisture, >80% available, at tuber initiation and a few weeks thereafter enhances brown center. First, there is a light brown appearance resulting from dead cells near the tuber's center. If, after a moisture stress and formation of brown center, tuber growth is gradually resumed, the surviving cells intersperse between the dead cells and a cavity is not formed. If tuber growth is resumed rapidly, the dead cells split apart forming a cavity and the disorder hollow heart. Fast-growing and very large tubers are more likely to show this disorder. Stem-end hollow heart usually follows brown center



Brown Center and Hollow Heart

Physiological Tuber Disorders

"Brown Center and Hollow Heart," Continued from page 1

and may occur in small tubers. Bud-end hollow heart occurs late in the season and is not often preceded by brown center. Some varieties are less susceptible.

Control Measures:

1. Plant closer.
2. Use larger, less aged seed pieces.
3. Establish good plant stands.
4. Avoid plant skips.
5. Apply potassium.
6. Spread nitrogen application through season (10-20 lb/ac weekly)
7. Schedule irrigation for constant and uniform tuber growth.

JELLY / GLASSY END

The terms jelly, translucent, glassy and sugar end all refer to various characteristics of the same disorder. This disorder is most associated with water deficit in plants due to low soil temperature, high air temperature, dry winds, and too much top growth with respect to tuber growth. It may occur early in the season around tuber initiation or late in the season near harvest. It may be associated with too rapid vine desiccation.

External Appearance: The stem end tends to be pointy and is also associated with a dumbbell tuber shape. Jelly end describes the flaccidity, wiggleness, of the stem end. Upon drying, the stem end becomes leathery and shrivels; the skin becoming wrinkled.

Diagnostic Method: Cut longitudinally from stem end to about two inches, and expose the cut surface.

Internal Appearance: The tissue at the stem end will have a glassy or opaque appearance hence the term glassy or translucent end. The affected area is sharply bordered from healthy tissue and usually extends less than two inches into the tuber.

Cooking Appearance: Upon frying, the stem end turns brown to black because of its high sugar content; therefore the terms sugar end or stem-end discoloration (SED). This is primarily a problem in french fry processing and Russet Burbanks are especially susceptible. Chips from the stem end are dark and unusable. After boiling or baking, stem end remains opaque.

Development: Inadequate soil moisture during early bulking coupled with high temperature seems to cause this disorder. Jelly end appears due to a lack of starch at the stem end resulting in a low specific gravity. Reducing sugars like glucose are high. The disorder is most prevalent in pointy and dumbbell-shaped tubers and in long tuber shaped varieties as Russet Burbank. Two general causal theories have been proposed. Starch breakdown or removal from the stem end when growth renews after stress. And, starch produced in the leaves is either not broken down and transported to tubers or, in tubers, the starch breakdown product is not reassembled into starch for some reason.

Control Measures:

1. Irrigate to maintain uniform growth. Use evapotranspiration (ET) or monitor soil moisture to schedule irrigation.
2. Allow gradual vine desiccation.
3. Irrigate somewhat after vine kill.
4. Don't plant after sugar beets because of low crop residue and compaction. Planting after corn or small grains is preferred with shallow incorporation of residue for good soil aeration and water infiltration.
5. Avoid highly salinated (sodium) fields especially with high levels of residual nitrogen. Avoid over fertilization with nitrogen.

6. Avoid tillage practices that compact soil. Last cultivation should be before emergence and first irrigation should be after emergence.

INTERNAL HEAT NECROSIS

Internal heat necrosis is associated most with high temperatures at harvest, acid soils and low calcium. Most affected are certain chipping varieties most notably Atlantic. Low soil moisture may have a role.

External Appearance: There is no outer appearance change. Reports have indicated that spindly sprouts may form from affected seed pieces.

Diagnostic Method: Cut transverse, cross-sectionally, through center and at bud end.

Internal Appearance: The necrosis appears as light tan, dark yellow to reddish brown flecks or specks; these may be dark brown or black in the most severe cases. They resemble the necrosis seen with chilling injury. Flecks usually cluster near the center toward the bud end and can appear similar to blackheart. The flecks are firm; there's no breakdown or rot. Vascular tissue is usually not affected but, in some cases, flecks may be confined to the vascular tissue at the bud end.

Cooking Appearance: Flecks fry brown. Fries and chips will be speckled around their center.

Development: This disorder is initiated as a result of harvesting during high temperatures and develops in storage over the first few months. Tubers near the ground surface are most affected. Heat necrosis is most common during hot and dry seasons and with potatoes planted in light soils. Low tuber calcium has been correlated with this disorder; whether a cause or result isn't clear.

Control Measures: Some measures reported to lessen incidence are

1. Lime of acid soils.
2. Add of calcium to deficient soils.
3. Establish good vine growth to shade ground (row closure).
4. Don't store tubers in ground long after vine death.
5. Schedule irrigation for seasonal growth.

VASCULAR DISCOLORATION

Non-pathogenic vascular discoloration is associated with low soil moisture and rapid, 1-3 days, vine death due to acid, frost, or mechanical kill. High temperature stress at vine kill increases the severity of the disorder.

External Appearance: There is no outer change of appearance.

Diagnostic Method: Slice transversely from stem end.

Internal Appearance: Disorder is characterized by a light tan to reddish brown speckling or a dark brown streaking in the vascular tissue. The speckling or streaking usually extends to about a half inch from the attachment point, but in severe cases may extend in the vascular system the length of the tuber. This disorder is readily mistaken for vascular discoloration due to *Verticillium* wilt or leaf roll net necrosis (pathogenic causes).

Cooking Appearance: Specks remain dark after boiling and baking. Chips from stem end will have a brown ring near their edge. Fries will have a brown band just below the stem-end cut.

Development: Tubers near full maturity are most susceptible. The disorder may be seen in the field before harvest and develops during the first two months of storage.

Control Measures:

1. Irrigate prior to vine desiccation.
2. Desiccate vines gradually, 1-2 weeks for complete kill.

Physiological Tuber Disorders

"Physiological Tuber Disorders"... Continued from page 2

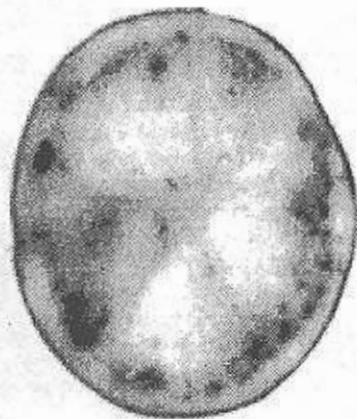
CHILLING

Chilling injury to tubers can occur in the field, in storage or in transit due to exposure to low, NON-freezing temperatures.

External Appearance: Surface injury appears as diffuse brown to black patches. Patches may be slightly shiny and are prone to molds.

Diagnostic Method: Cut through affected surface. If no external appearance, cut through stem end and transversely near stem end.

Internal Appearance: Affected internal tissue appears smokey-grayish and diffuse similar to early stages of leak. A net necrosis, brown specks, in the vascular ring at the stem end is common ("mahogany browning"). It is similar to leaf roll net necrosis. But, unlike the latter which is scattered in tuber (star burst effect), chilling net necrosis is confined in and around the vascular ring. (Phloem tissue is the most sensitive to chilling.) In severe cases, the specks enlarge and are blackened. Brown streaks into tuber may appear.



Chilling

Cooking Appearance: When boiled, tubers turn gray to black. Due to the accumulation of glucose, affected tissue turns brown during frying resulting in dark chips and fries.

Development: Only a few hours of exposure to temperatures of 32 to 35°F is needed for chilling injury. The disorder is absent when temperatures are above 38°F. Immature tubers, harvested too soon after vine desiccation, are mostly affected. Chilling impairs and delays wound healing. Poor sprouting occurs with affected seed tubers. Chilling lowers internal quality and reduces storage life. Affected tissue turns sweet due to breakdown of starch storage organelles (vacuoles) and subsequent breakdown of starch to glucose by cellular enzymes. Therefore, affected tubers are not suitable for processing. Affected tubers should not be used for seed because they sprout poorly and there is potential of seed decay in the ground.

Control Measures: Avoid exposure to temperatures below 38°F. There are varietal differences in tolerance to level of coolness and its duration.

1. Harvest before soil temperature cools to near freezing.
2. Tarp truckloads.
3. Store seed and table potatoes at 38-40°F.
4. Ventilate to dry out chilled tubers and avoid possible rot.
5. Keep storage insulation dry.
6. Don't store against an outside wall.

FREEZING

Freeze injury to tubers can occur in the field, in storage or in transit due to exposure to below freezing temperatures, <30°F. In storage of seed and table stock tubers, freezing is usually associated with poor ventilation and poor insulation.

External Appearance: Prior to thawing, affected tuber area is hard. After thawing, affected tuber area appears wrinkly and flabby. It may have a "weeping" effect, that is, water will leak from tuber surface.

Diagnostic Method: Cut through affected area.

Internal Appearance: Although seemingly similar to chilling, the underlying tissue will be bluish-grayish and the margin will be sharply defined, not diffuse. Also, unlike chilling, there will not be a net necrosis. Upon thawing, affected tissue will gradually change from a dull, off-white (grayish) color to pinkish-reddish to brown-black. The tissue breaks down from being hard (frozen) to a watery texture, soft and wet.

Cooking Appearance: Not suitable for table stock or processing. Tissue breaks down during cooking, such as sloughing during boiling and becoming a watery mush during baking. May be used for dehydration.

Development: Ice crystals form in cells upon freezing. These puncture the cell and organelle membranes. Upon thawing, the cells lose structural integrity and spill out their contents. Bacterial soft rot commonly will attack thawed affected tissue in storage. Don't use for seed due to poor sprouting and high susceptibility to soft rot.

Control Measures: Avoid exposure to temperatures below 30°F. If freeze occurred in the field, discard affected tubers; don't store them. Don't mix tubers from fields exposed to a freeze (tend to get soft rot) with those that weren't.

1. Harvest before soil temperature drops to freezing.
2. Tarp truckloads.
3. Don't store against an outside wall.

BLACKHEART

Blackheart can develop around harvest, in storage and in transit as inside trucks. It is caused by an oxygen deficit at the center of the tuber.

Oxygen deprivation results in asphyxiation, loss of respiration, and death of cells.

External Appearance: It can not be detected externally.

Diagnostic Method: Cut longitudinally.

Internal Appearance: Blackheart appears as an internal browning to blackening of center tissue. Usually, there is no cavity. Pattern is irregular but margins are well defined. Affected tissue is firm, not soft as with leak, but, when temperature is greater than 65°F, it may turn soft and inky. There is no odor as with leak.

Development: Any pre-harvest, storage and transit condition that prevents oxygen from reaching the tuber center will result in blackheart. These conditions are commonly poor ventilation, water-logging, long exposure to high field temperatures (>90°F) before harvest, and prolonged storage at low temperatures (<35°F). Tubers used as seed can have lower vigor and stand since tuber starch reduced in bulk and may not support emergence.

Cooking Appearance: Boiled or baked tubers will be black in the center. Chips usually have a black center or a hole. Fries will be black in the middle or be split in two.

Control Measures: Good ventilation in storage prevents blackheart.

1. Avoid poorly drained ground. Avoid flooded areas.
2. Avoid closed bins, deep piles and poor ventilation.
3. Avoid poorly aerated trucks and storage.
4. Avoid temperature extremes, inhibit diffusion of oxygen through tuber.



Blackheart



Physiological Tuber Defects Summary

<u>Defect</u>	<u>Diagnostic</u>	<u>Key Symptom</u>	<u>Associated with</u>	<u>Reduced By</u>
Brown Ct. Hollow H.	cut along long axis	brown area or cavity along axis	rapid tuber growth after stress	good stand, irrigation timing, N timing, K
Jelly End	view & cut stem end	flabby end opaque inside	water deficit in plant, rapid vine death	irrigation timing, less N, air soil slower vine kill.
Heat Necrosis	cut through bud end and center	dark flecks at center of bud end	high temperature at harvest, acid soil, Ca	good row closure, slower vine kill, liming, Ca.
Vascular Discolor.	sequential slicing of stem end	speckling of vascular tissue	rapid vine kill & low moisture	slower vine kill, irrigate after vine kill.
Chilling	view, cut into stem end	patches on skin specks in ring gray area	low temperature	ventilate bins, store @ 38°F, protect from cold.
Freezing	feel, cut through	wet surface discolored core watery	freeze	harvest earlier protect from cold
Black Heart	cut along long axis	blackened center tissue	oxygen deficit	ventilation drained field

Suggested Literature:

- "Potato health management" APS Press. 1993.
- "Detection of potato tuber diseases and defects" Cornell Bull. #205. 1986.
- "Brown center and hollow heart in potatoes" Idaho CES Bull. #691. 1989.
- "Management practices & sugar end potatoes" PNW Bull. #427. 1992.