

Working Party on Agricultural Quality Standards

Specialized Section on Standardization of Seed Potatoes

Fortieth session

Geneva, 14-16 March 2011

Item 5 of the provisional agenda

Internal temperature-shock injuries

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Note by the Secretariat

This note has been prepared by the delegations of Canada and the United States as a follow-up to the discussion at the Extended Bureau meeting in Bandung in October 2010.

The discussion during the last UNECE Seed Potato Section meeting about the document, “Internal defects caused by low temperatures“, submitted by Canada seemed to leave doubt about whether low temperature injury to the tuber was caused by temperatures higher than 0C, but close to freezing.

The description in the Potato Compendium is: "Low temperature tuber injury may range from outright freezing and killing of some or all of the tubers to graduation of injury (chilling) following prolonged exposure to temperatures slightly above freezing. Tubers may be frozen in the ground before harvest or injured later by low storage temperatures. Tubers of many cultivars freeze at temperatures below -1.7C. Freezing results in formation of ice crystals within the tissue, followed by rapid death. Chilling results in eventual death of cells or tissue even though the tissues may not actually have been frozen." (Hooker, Potato Compendium, page 8).

This discussion is intended to separate “low temperature (chilling) injury” from “frost damage”.

“Low temperature (chilling) injury” is caused at temperatures lower than 3C, depending on variety. There are varieties that can be stored at 2C without problems, but other varieties are injured by temperatures below 3C.

It is generally accepted that frost damage is caused by temperatures below -1.7C, starting in the vascular ring. (Turkensteen and Mulder, Aardappelziektenboek, page 323)

The Canadian document below refers to “low temperature (chilling) injury”. Low temperature injury is an actual tuber injury as described in the Canadian document. The symptoms are also described in the Canadian document below.

In the US “frozen, soft rot and wet break down” are in the same category and tolerance. Including the same under “soft rot” in the UNECE standard may be worth considering.

Our suggestion as definition for low injury is the same proposed definition:

A low temperature injury consists of internal damage to the tuber caused by exposure to temperatures below or slightly above freezing, even for a relatively short period of time. A greyish discoloration predominantly of the vascular tissue can occur within hours after exposure. Low temperature injury results in a tuber with no, or very poor, germination.

Internal defects caused by low temperatures: Factors to consider

(Document GE.6/BUR/2010/4 submitted by the delegation of Canada to the meeting of the Extended Bureau in Bandung)

Low temperature injury of potato tubers can occur if they are exposed to a heavy field frost, have been excessively chilled in storage, or are exposed to cold temperatures while in transit.

The distinction between frozen and unfrozen tissue in low temperature-damaged tubers is usually clear. Externally, chilled (but unfrozen) potatoes usually appear to be sound and damage cannot be assessed unless tubers are cut. If frozen, the tuber’s appearance is wrinkled and flabby and internal tissues generally turn bluish grey to black in response. Frozen tissue, once thawed, may discolour progressively from off-white to pink and red, and eventually to brown, grey or black. These tubers break down promptly into a soft watery mass, leaving a chalky residue as the water evaporates.

Symptoms of chilling are somewhat variable depending on the temperature, exposure period, and potato variety (since % moisture content varies by variety). Development is most rapid at environmental temperatures below or slightly above freezing (0 - 2.5 °C),

and is progressively less severe from 3.8 - 4.4 °C. Chilling injury is typically seen as streaks of smoky grey discoloration in the vascular tissue of the tuber.

Long-term potato storage temperatures may vary; however, storage temperatures are generally between 3 - 7 °C, depending on the variety and desired end use. For example, some tuber varieties must be stored at temperatures between 5 - 7 °C in order to maintain appropriate sugar content for subsequent processing. Chilling causes a reduction in sugar content which can change both the flavour and colour when cooked (i.e., sweet flavour, turning grey to black when boiled, or brown discoloration in french fries or chips).

Blackening of the phloem, due to selective low temperature injury to this tissue, can also occur and can resemble viral net necrosis (which occurs due to death of the phloem resulting from current season infection with potato leafroll virus). The symptoms of net necrosis may easily be confused with 'frost necrosis' resulting from chilling. However, net necrosis differs from frost necrosis in that the dots and streaks of viral necrosis are more clearly defined and occur in concentric rings.

Low temperature damage tends to have a greyish colour and is found more in the outer tissue (photograph No. 1). However, viral damage tends to have a brown coloration and appear more in the internal potato tissue (photograph No. 2).

Damage from chilling is usually visible within hours whereas expression of symptoms of viral infection may take days or months, and may vary depending on the time of infection in the field, the variety and physiological age of the tuber.

Chilled potatoes should not be used for seed as cut surfaces may not heal and seed piece decay may result. In addition, germination in chilled potatoes is slow and sprouts generally die off or do not produce a viable plant.

Low temperature injury to potato tubers can be reduced or prevented by:

- Maintaining storage at temperatures above 4 °C;
- Maintaining proper ventilation and temperature control;
- Utilizing varieties less susceptible to injury.

Proposed definition:

A low temperature injury consists of internal damage to the tuber caused by exposure to temperatures below or slightly above freezing, even for a relatively short period of time. A greyish discoloration predominantly of the vascular tissue can occur within hours after exposure. Low temperature injury results in a tuber with no, or very poor, germination.

Placement of definition:

It is proposed to include this definition in Annex VII, with sample photographs included in Annex VIII (would need to add an Annex VIIIb or modify the title of Annex VIII).

Proposal for inclusion of tolerances in the standard:

Annex III could include a subsection 8, with tolerances for "chilling or frost damage". The tolerance should be the same for Pre-Basic, Basic and Certified since chilling injury it is not a pest or disease. As a reference source, Canada's Seeds Regulations Part II provides a tolerance as follows:

Chilling tolerance 2% at shipping point and 3% at destination for all tubers.

Possible elements for inclusion in the standard for further consideration by the working group:

- A comparative or diagnostic key for chilling damage versus viral necrosis damage
- Morphology photographs showing the internal structure or cross section of a potato tuber (Vascular tissue, phloem, etc.)

1. Chilling Damage



Source: ON Ministry of Agriculture, Potato Field Guide: Insects, Disease and Defects. Publication 823, Plate 458, 2004.

2. Viral Necrosis



Source: ON Ministry of Agriculture, Potato Field Guide: Insects, Disease and Defects. Publication 823, Plate 344, 2004.