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Guide to Seed Potato Tuber Inspection

Guide to Seed Potato Tuber Inspection

The following document contains the draft Guide to Seed Potato Tuber Inspection, as discussed by the participants of the Bureau and Rapporteurs' meeting in Kimberley, South Africa, in March 2016. It also includes comments on the post-session document submitted by the delegation of Germany. The text of this document is submitted to the Specialized Section for review.

UNECE Guide to seed potato tuber inspection: Recommended practices

1. Introduction

This Guide refers to the UNECE STANDARD S-1, concerning the marketing and commercial quality control of Seed Potatoes.[1] Knowledge of the relevant requirements is essential for the inspector.

Inspection is the visual examination of plants, tubers, containers, equipment or facilities by an authorized person, to determine compliance with regulations. Confirmation of symptoms can be supported by laboratory testing, if necessary.

All seed potato lots to be certified under the UNECE Standard must be inspected before marketing. The definition of lot is in the UNECE Standard. Where reference to the UNECE Standard is made, the requirements of the UNECE Standard must have been met. National standards can be used in conjunction with the UNECE Standard.

2. Scope of inspection

The scope of the inspection is to check the conformity of the lot with the UNECE Standard.

2.1 Inspection for Conformity

The inspector is to inspect tubers within a lot to establish whether they meet the standards for certification, after sorting and grading but before dispatch.

In addition to the lot inspection, inspectors may observe the seed potatoes being graded in order to obtain a general impression of their quality and uniformity.

2.2 Requirements for inspection:

- The seed lot is identified and eligible
- Containers are accessible
- Containers have not been in contact with sprout inhibitors or other chemicals potentially having effect on sprouting.

2.3 Results

The results of the inspection are recorded (see Section 8) and are valid on the day of inspection because some quality aspects may change during storage or transportation e.g. progressive diseases.

3. Training

In order to qualify to perform inspections, the inspector must have completed the appropriate training.

[1] The latest version of the Standard is available on the UNECE website at: http://www.unece.org/trade/agr/standard/potatoes/pot_e.html

Initially inspections must be done in collaboration with a "senior/mentor" inspector (mentoring/shadowing process).

Prior to inspecting lots on their own, newly trained inspectors should undergo an evaluation to ensure they are qualified to conduct the inspection by themselves.

There is a desire and willingness among countries participating in the UNECE to co-operate for a better understanding of inspection practices. There is also an opportunity for this activity to contribute to capacity-building for countries with limited experience in seed potato classification or those with a limited resource base for training. Those interested in participating in collaborative work may contact the UNECE secretariats who will co-ordinate this activity.

4. Information available to the inspector

- Location of the lot
- Reference number of the lot
- Eligibility of the lot for certification
- Intended certification class
- Quantity of the lot
- Specific requirements (e.g. market, size)
- Possible chemical treatment of the lot

5. Bio-security

Inspectors should undertake measures to avoid contamination from one inspection location to another. They should observe any on-site bio-security practices, including the use of clean knives, which may be provided on-site. Additional precautions should be taken if a zero tolerance disease is suspected.

6. Sampling

A random sample of the seed potato tubers from the lot to be inspected should be taken and set aside for tuber size, grade and quality inspection. The tubers need to be sufficiently free of soil to allow for a visual inspection, i.e. no caked dirt. Generally, it is not an obligation to wash the sample; however, if it is not possible to conduct an objective tuber inspection, the sample shall be washed.

During the inspection process some tubers of the sample may be cut to establish the presence or absence of internal defects. If tuber samples are to be assessed for internal defects and diseases, they should be cut along the longitudinal axis, drawn through the widest part of the tuber (i.e. from end to end), and examined. A shallow cut of the stolon-end may reveal discolorations or oozing of the vascular ring, that otherwise may be missed.

A tuber has two ends. The “heel-”, “stolon-”, or “stem-end is where the stolon was attached. The opposite end is called the “apical-“, “rose-“, “distal-“, or “bud-end”.

Samples must be representative of the lot to allow for an accurate inspection and certification of the lot. Accessibility to the sample should not weigh on the importance of the sample. Where accessibility is an issue the inspector may be unable to complete the inspection.

6.1 Number of samples

It is the inspector's responsibility to examine enough samples to ensure an accurate picture of the lot. The minimum sampling rate can be found in the Standard. The sample size may be increased if the tubers are large. The sample may be collected either during the process of grading at the end of the grading line, or from at least two containers. The number of sub-samples should be increased depending on the size of the lot. In the case of bulk loads, the entire load will be considered the lot. Then the sub-samples must be randomly taken throughout the lot. The sub-samples are individually recorded on the note sheet. The "Application of tolerances" does not apply to individual sub-samples; the counts are averaged.

7. Reasons to stop tuber inspection:

- Presence of a zero-tolerance disease or pest which ultimately, if confirmed by diagnostics, results in the rejection of the lot. The inspector should inform the DA
- Lot identity is not provided
- Sampling is hindered or interfered with resulting in the lack of access to the sample
- Conditions deemed dangerous for the inspector
- Tuber surface cannot be observed due to excessive caked dirt (App. 1, Pic. 1), treatment residues on tubers, or other reasons.
- Seed has been cut
- Unsuitable containers (e.g. presence of old labels, adhering soil, rogue tubers etc.)

8. Note sheet and inspection certificate

An inspector should note findings and counts on a note sheet in a legible and accurate manner or store it by electronic means. All information on the tuber inspection report should be supported by information on the note sheet. It is the responsibility of the inspector to ensure that all information is properly recorded.

8.1 Official records of the tuber inspection

The official record of the tuber inspection should contain:

- The regulations with the “UNECE Standard”, if appropriate
- Content: "Seed potatoes"
- The Designated Authority (DA) or its recognized initials
- Country and/or region of production
- Variety, Category and class, where appropriate, field generation
- Reference number of the lot, including where appropriate, the producer's identification number
- Tuber sizes
- Net weight of the lot
- Declared net weight of the containers
- Sample size
- Specific references to the containers inspected (if relevant)
- Inspection findings against the tolerances of the Standard
- Date(s) of inspection
- Decision regarding conformity of the lot
- Identification of the inspector

The report may also note:

- Chemical treatments, sprouting etc.

8.2. Classifications

Classifications in the UNECE Standard are according to categories which are sub-divided into classes. The records of the seed lot are necessary for the inspector to allow classification and labelling of the seed lot.

9. Containers

The term “container” is not specifically defined in the Standard but may include bags of any size, bins, shipping containers, and bulk transport such as trucks and railway cars. Section VI.A of the Standard states, in relation to the condition of containers, that bags must be new; other containers may be reused provided that they are clean, including an appropriate level of disinfection and disinfestation. The inspector may check for the absence of old labels, rogue tubers, adhering soil etc. from reused containers. .

9.1 Closing and sealing of containers

Containers should be sealed officially or under official control. Persons sealing containers may be inspectors or other persons authorised by the DA to undertake this activity on its behalf.

Prior to closing containers the inspector or authorised person should check the condition of the containers to ensure they meet the requirements of the Standard unless this check was made during tuber inspection.

In the case of sealing under official control, the DA should verify that labels and seals have been applied appropriately.

If a shipping container contains bags or bins each containing a different variety, category, class, size, or origin of seed potatoes the inspector should ensure that each bag or bin is closed and labelled and the contents cannot spill and become mixed during shipping. In the case of bins this may be achieved by using bins with closed lids.

Containers should be sealed by a method that ensures that it becomes obvious if the container has been opened, and should ensure that the container cannot be re-closed without this tampering being evident. Bags may be sealed by sewing the official label into the bag as the bag is sewn closed. In other cases an official seal should be applied to seal the container.

Although not part of certification, shipping containers may also require sealing over and above sealing seed potato containers. They can be easily sealed by inserting a numbered seal through the door locking handle. It may be better to use a shipping company seal as the number of this seal will be entered into the consignment's shipping documents. The consignee will be able to check the number and confirm that the number of the seal matches the seal applied at container closing.

Seed potatoes transported in bulk transport containers are more difficult to seal. Vehicles with loose seed potatoes may be covered with a tarpaulin which is then closed with a cord and sealed. All opening points are sealed. Tamper evident seals can be used to seal the tailgate or opening mechanism of the vehicles. Examples of how seals can be applied can be found in Appendix 5.

Sometimes containers need to be opened before arrival at their destination. This can, for example, be to allow for re-inspection, Customs inspection, or phytosanitary inspections before loading of containers onto ships.

If containers are opened they should be re-closed under the authority of the DA once the DA is satisfied that the contents have not been tampered with.

9.2 Declared chemical treatment

The nature of the active substance of any declared chemical treatment of the seed potatoes shall be indicated on the outside of each container, on a tear-resistant or adhesive label. Although the Standard states that it may be the official label, it is recommended that the supplier provides a label declaring any chemical treatments that have been applied. This information may also appear on the inside of each container.

Declaration of the chemical treatment is the responsibility of the producer, in which case, the DA should ensure that it is stated on the label. The DA has no responsibility for the selection or use of chemicals that have been

applied to seed lots.

The inspector should use appropriate Health and Safety measures when inspecting treated seed lots.

10. Official Label

Each container shall be sealed and bear on the outside an official label which has not been previously used; the label shall be:

- White with a diagonal purple line for Pre-basic seed
- White for Basic seed
- Blue for Certified seed.

Reference to the UNECE Standard may be included on the label.

The official label will indicate:

- The relevant standard and, if appropriate, “UNECE Standard”
- Nature of the contents: "Seed potatoes"
- The Designated Authority (DA) or its recognized initials
- Country and/or region of production
- Reference number of the lot, including, where appropriate, the producer's identification number
- Month and year of closing
- Variety
- Category and class and, where appropriate, record of field generation
- Size
- Declared net weight.

Each container shall have on the inside an official statement of the same colour showing at least: the DA or its recognized initials; the reference number of the lot which includes the producer's identification number and the variety. The statement shall be so worded that any confusion with the official label shall be avoided. If an adhesive label or a label of untearable material is used, then such an official statement is not required.

10.1 Re-labelling

If a second check of the lot is conducted, the authority which carried out the second check must be stated on the label, as well as the date of the re-closing. If a new label is necessary, this must show the particulars which appeared on the original label, the date of the re-closing, and the authority concerned.

10.2 Supplier’s label

Although not part of certification, each container may also be accompanied by a special label of the supplier, provided it is not in conflict, or can be confused with the official label. The supplier’s label is not a substitute for the official label.

11. Origin

It is the inspector's responsibility to verify the origin from the client or certification records.

12. Tuber size

The tuber size requirements are in Chapter V of the Standard.

Pre-basic TC is exempt from the minimum sizing requirements.

The minimum size of tubers must be such that they do not pass through a square gauge of 25 mm; for varieties having, on average, a length of at least twice the greatest width, the square gauge must not be less than 25 mm. In the case of tubers, which are too large to pass through a square gauge of 35 mm, the difference between the maximum and minimum limits of size should be expressed in multiples of five.

The maximum variation in size between tubers in a lot must be such that the difference between the dimensions of the two square gauges used does not exceed 20 mm, unless the buyer and seller agree to deviate from this requirement; in which case the size variation of the tubers should be documented on the label.

In every case, the lot shall conform to the distribution of tuber sizes of the harvested crop within the size specified on the label.

A tuber is within the maximum size when the inspector can drop the potato through the sizer when the longitudinal axis is at right angles to the sizer. A tuber is considered above the minimum size when the tuber is held by the sizer regardless of the position of the tuber.

The inspector should examine each sample to ensure the lot meets the size requirements, measuring as many of the smallest and largest tubers as is necessary. Sizing of tubers at maximum or minimum size is generally sufficient, unless tubers in the lot deviate from a standard size distribution.

The size assessment is made separately from the assessment from other defects.

Potatoes under the minimum or over-the-maximum diameter should be weighed to determine the percentage.

13. Faults as external defects and disorders

External defects and disorders can be observed on the outside of the tuber. Cutting may be required to determine the extent of the defect.

Observation of symptoms of the diseases specified in Annex III B, during inspection, or at any other time, will result in the lot being rejected, if confirmed by appropriate diagnostics.

13.1 List of faults as external defects and disorders

Picture references are to the pages of the “UNECE Guide to Seed Potato Diseases, Pests and Defects” or to Appendix 1.

Air cracks (App. 1 picture 2) are longitudinal cracks, often fresh and without apparent connection with mechanical injury. They usually occur during the harvesting and bagging process, although some may occur after bagging if the bags are handled roughly. They are not countable.

Bruises (Page 103) may be caused by mechanical damage. Mechanical damage is counted under bruise or cut. The discolouration varies but is generally brown, grey or black. The skin and flesh of the potato may be broken or torn or may simply show discolouration. The size and shape of a bruise may vary considerably.

Bruises are quality defects. Fresh or recent bruises may be pink or vary from a bright shiny grey to jet-black, but they do not show dry or dry starchy flesh.

Old bruises may vary from dull-grey to light-brown and show up dry or starchy in the tuber flesh. There may be a separation or some corkiness of the flesh.

A deposit of powdery, discoloured starch will frequently be noticed in bruises or cuts. Inspectors should be careful not to confuse this starch deposit with *Fusarium* rot. The difference can be readily noted upon cutting the potato. If the flesh next to the deposit is affected, the condition has been caused by some decay. If the flesh is sound, it should be considered only as a bruise.

Pressure Bruise (Flattened or depressed areas) (Page 102) may generally be found after several months of storage. They are most often the result of dehydration at pressure points.

They exhibit a rubbery feel and a slight wrinkling or a soft elasticity of the skin over the flattened area. They are not countable unless the underlying tissue is discoloured.

The tolerances for external defects are:

Tubers with the following external defects are countable:

- Pressure bruises: spots of more than 10% of the tuber surface and discolouration of more than 10 mm in depth.
- Mechanical damage: more than 10% of the total tuber weight (when removed by a straight cut) is affected or any damage which is not healed
- All categories 3% by weight

Chilling injury (Page 99) causes the tuber flesh to become reddish-brown to black. Symptoms on the tuber surface are a dark-brown, sometimes sunken patch. Symptoms may be internal. All affected tubers are countable. The tolerances are:

- 0% by weight for Pre-basic TC and 2% for other categories.

Cuts are countable as mechanical damage if more than 10% of the total tuber weight (when removed by a straight cut) or any damage which is not healed. The tolerance for total external defects (e.g. damaged tubers) is applied: 3% by weight in all categories.

Earth, clod and extraneous matter. The tolerances for "extraneous matter" are applied:

- 1% by weight for Pre-basic TC, Pre-basic 2% for Basic and Certified.

Elephant hide (App. 1 Pic: 3) may be caused by environmental and physiological factors. The symptoms are roughened scaling of the skin unlike scab infections. The skin often appears darker and thicker than normal with deep checking, cracking or scaling. Affected tubers are not countable, but it may be noted when requested.

Enlarged lenticels (App. 1 Pic: 3) may be due to excessive moisture and are not countable unless accompanied by rot deterioration of underlying tissue.

Flea beetle (*Epitrix*) (Page 89) is a small insect that causes an injury by feeding on or near the surface of the tuber. The results are brown splinter-like pegs extending 3 to 6 mm into the potato. There are countries with a zero tolerance for this type of injury**. Pest damage is countable for tubers with more than 10 holes or with more than 3 holes of 5 mm or more in depth.**

Tolerances:

- Pre-basic TC 0% by weight
- Other categories 4% by weight

Freezing injury (Page 99) means that the potato is frozen or shows evidence of having been frozen. Symptoms vary greatly. Tissue at the stolon-end of the tuber is more sensitive to freezing than those at the apical-end. Cells around the vascular ring are more susceptible to freezing than other cells in the potato. Potatoes injured by freezing may be firm but would show internal discolouration near the stolonstolon-end. Potatoes that were frozen will become soft and watery upon thawing (wet breakdown) or in dry air they become dry, leathery, and granular with chalky white masses of starch. Often there is a clear line of demarcation between affected and healthy flesh. Field freezing will generally manifest first on areas that are sunburned and develop bluish-grey blotches beneath the skin along with soft, flabby, watery areas.

All tubers that are frozen or showing freezing injury are countable. The tolerances for "wet breakdown due to extreme temperatures" apply:

- 0% by weight for Pre-basic TC, 0.2% for Pre-basic, and 0.5% for Basic and Certified.

Grass root symptoms, (App. 1, Pic. 05) e.g. quack nut and wire grass may have roots growing into and even through potatoes. Grass damage is not countable.

Greening caused by exposure of the tuber to light is not countable for seed potatoes because there is no injurious effect on the quality of the seed.

Growth cracks (Page 100+101) usually follow the long axis of the potato and are a result of internal pressure exceeding the tensile strength of surface tissues during tuber enlargement. Growth cracks are not countable. Cracking may also be caused by pathogens or chemicals, in which case, further investigation may be required by the inspector.

Grub and Slug Damage (App. 1, Pic. 6) is a pest injury affecting potatoes. Grubs or slugs eat away at the skin and flesh of the potatoes leaving holes, usually of considerable size. They may be countable as pest damaged tubers. The tolerance is:

Tubers with more than 10 holes or with more than 3 holes of 5 mm or more in depth are countable

- Pre-basic TC 0% by weight
- Other categories 4% by weight

Pink eye (Appendix 1, Pic. 07**)** symptoms are pinkish blotches near the eyes and mostly around the apical-end of the tubers due to the pink underlying tissue. The internal tissue is firm to corky with pink to reddish-brown colour. Black areas and cavities may also occur. The discoloured tissues around the eyes may turn light-brown, become wrinkled and cracked. Pink eye may be confused with late blight, but it does not have the brick-red granular tissue that is characteristic of blight. It is a physiological defect that may give access to secondary disease organisms. Tubers with deteriorated tissue underneath the pink eye are countable. In the Standard, there is only a tolerance for dry rot (pink eye may develop a rot), i.e.:

- 0% by weight for Pre-basic TC, 0.2% for Pre-basic, and 1% for Basic and Certified.

Potato Spindle Tuber Viroid (PSTV). (Page 60) Tubers may be more elongated than normal or they may be typically spindle-shaped and covered with a remarkably large number of eyes. The tissue around the eyes is slightly prominently swollen and looks like heavy “eyebrows”. In serious cases the tubers may be deformed showing deep growth cracks.

- Zero tolerance for PSTV in the Standard.

Rhizoctonia (Black scurf). (*Rhizoctonia solani)* (Page 35) Tuber blemish is caused by dark brown or black sclerotia forming on tuber surface. Coverage may be difficult to assess accurately on unwashed dirty tubers. Growth cracking accompanied with star-like elephant hide netting and trumpet-shaped holes can be a symptom of Rhizoctonia. The tolerances are:

- 0% by weight for Pre-basic TC (0% surface cover), 1% for Pre-basic (>1 % surface cover), and 5% for Basic and Certified (>10% surface cover).

Rodents and Birds. Rodents make cavities that bear teeth marks in the form of corrugations or ridges. Bird damage shows as identified pit-like markings lining the cavity. They may be countable as mechanically damaged tubers.

- Mechanical damage: more than 10% of the total tuber weight (when removed by a straight cut) is affected or any damage which is not healed

- 3% by weight in all categories.

Root knot nematodes (*Meloidogyne* spp.) (Page 85) may produce galls on the tuber surface, depending on the cultivar. Tuber galls appear as small raised lumps above the developing nematodes giving the skin a rough appearance. Galls may be grouped in a single area or scattered near the eyes. When infested tubers are cut small brown spots may be seen within the tuber cortex. Each spot represents a mature female surrounded by a mass of brown eggs.

- Zero tolerance for this symptom in the Standard. Infestation may sometimes show no external symptoms. However, the tolerance is also zero for internal symptoms.

Root rot nematodes (Potato rot nematode**, *Ditylenchus destructor***). (Page 81) Initial symptoms are grey to white mealy spots beneath the tuber surface (visible if cut or peeled). The symptoms progress towards the vascular tissue and the affected spots coalesce and darken, and the skin becomes papery and cracked. Affected tubers are susceptible to secondary infection by opportunistic fungal or bacterial pathogens.

- Zero tolerance for confirmed symptoms in the Standard.

SCAB

Common scab (and/or **netted scab, S*treptomyces* spp)** (Page 70+71) ranges from superficial, corky lesions to extensive raised scabs occurring either singly or in groups. In netted form as a superficial corky russeting of the skin. Tubers affected over a specified % of their surface are countable. The tolerances are:

- 0% by weight for Pre-basic TC (0% surface cover), 5% for all other categories (>33.3% surface cover).

Rough raised netting affects the skin of potatoes; it may be fine, raised and/or rough. However, netting is only countable when it shows the symptoms of netted scab and is rough and raised.

- The tolerances for netted scab are part of the total tolerances for scab caused by *Streptomyces* spp. (common and netted).

Russet scab (App. 1 pic 08) is a roughening, scuffing, or cracking of the tuber skin, sometimes occurring in localized areas or sometimes over most of the tuber surface. The affected tissues vary from light tan to brown in colour, and may consist of a superficial cork-like layer or have a cushion-like appearance. It may have a physiological origin with no link to a causal organism, and therefore is not counted.

Powdery scab. **(*Spongospora subterranea)*** (Page 39) Symptoms are round individual raised scabs present on tubers at harvest, lesions erupt exposing brown powdery tissue (spore balls) leaving tattered fragments of skin along the edge of the lesion. Infection at time of eye development can result in outgrowths (cankers) of varying sizes developing at the apical-end of tubers. Galls can also form on stolons and roots. Tubers affected over a specified % of their surface (see appendix 2) are countable. The tolerances are:

- 0% by weight for Pre-basic TC (0% surface cover), 1% for Pre-basic (> 10% surface cover), and 3% for Basic and Certified (> 10% surface cover).

Different types of scabs may be difficult to distinguish from one another.

Shrivelled tubers (Page 107) are countable when they have become excessively dehydrated and wrinkled, including dehydration caused by silver scurf. The tolerances are:

- 0% by weight for Pre-basic TC, 0.5% for Pre-basic, and 1% for Basic and Certified.

Silver scurf (***Helminthosporium solani)*** (Page 21) is a tuber skin blemish disease which starts as small, round, silvery patches on the skin. In humid conditions, dark sooty conidiophores can develop around the edge of lesions. Large silvery patches develop as individual lesions, expand, and merge during storage. Tubers can become dehydrated leading to shrivelling. Symptoms are not countable unless the tubers are shrivelled.

Sprouts. Tubers with sprouts are not countable unless they have led to shrivelled tubers.

Tuber moth. (*Phthorimaea operculella)* (Page 93) At harvest affected tubers may show little visible evidence of infestation but may be harbouring eggs or young larvae. As the larvae feed on the tubers damage becomes extensive with galleries just under the skin or deep into the tuber. Affected tubers may lose excessive moisture through the wounds becoming shrivelled. Secondary infection by fungal pathogens can also lead to tuber rotting. Countable tubers are those affected by galleries covering more than 20% of the cut surface. The tolerances are:

- 0% by weight for Pre-basic TC and 4% for all other categories
- Zero tolerance for live insects and larvae.

Tuber necrosis (e.g. PVY^{NTN} (Page 59), TRV (Page 55), or PMTV (Page 51) is seen in some varieties. It may be caused by some strains of PVY, when symptoms are favoured by high temperatures. The tuber symptoms progress in store from a smooth pink to a reddish-brown necrotic ring or arc on the tuber surface. Then they become raised and finally become an unsightly sunken crater which may turn a darker brown. The lesions remain superficial and there are no necrotic arcs within the tuber flesh which distinguishes this disease from spraing caused by PMTV or TRV, which is brown, corky arcs and spots in the tuber flesh, sometimes visible on the skin surface.

Variety variation makes differentiation on visual symptoms problematic. Other tuber symptoms may include growth cracking and elephant hide.

Wart disease (***Synchytrium endobioticum)*** (page 41) symptoms are cauliflower-like growths on the tuber that were cream and generally have become black when the crop died.

- Zero tolerance in the Standard.

Wireworm (*Agriotes* / *Tandonia* / *Arion* spp. /) (page 87) larvae bore small shallow holes or deeper tunnels into the tuber. Tunnels are always narrow (unlike slug damage) but can be extensive. Wireworm damage provides an entry point for other pathogens which may lead to tuber rots. When the hole is recently made, it may appear as a small dirty hole, however when it has been made early in the growing season the hole may be lined with new skin growth.

- Pest damage is countable for tubers with more than 10 holes or with more than 3 holes of 5 mm or more in depth.

Tolerances:

- Pre-basic TC 0% by weight
- Other categories 4% by weight

14. Faults as internal defects and disorders

Internal defects are defined by the fact that there is no apparent damage to the surface area of the potato unless the inspector cuts the tuber. Discolouration in the vascular tissue is considered internal.

Sampling to determine the presence of internal defects accurately requires the inspector to use good judgment. The inspector may cut a certain predetermined number of tubers or additional numbers when a problem has been discovered.

All cut samples should be recorded with the number of potatoes cut to determine the percentage of internal defects.

Symptoms of internal defects are not countable unless it is determined that they are caused by a transmittable disease or are injurious to the yielding capacity of the seed.

14.1 List of faults as internal defects and disorders

Blackheart (App. 1 Pic: 09) generally may occur when the potatoes are exposed to high temperatures with an insufficient air supply. The internal symptoms are a dark-grey to purplish discolouration which later becomes jet-black. The discoloured areas are usually sharply set off from the healthy tissues. Generally the discolouration is restricted to the heart of the potato, but frequently radiates to the exterior as well.

- Not countable.

Chilling injury (Page 99) causes the tuber flesh to become reddish-brown to black. Symptoms on the tuber surface appear as a dark-brown, sometimes sunken, patch. Symptoms may be internal. It should be noted by the inspector, as it may have an influence on the yielding capacity of the affected seed potatoes. The tolerances are:

- 0% by weight for Pre-basic TC and 2% for other categories.

Heat or drought necrosis causes grey, yellow or brown discolouration in the vascular system and may occur at either the stolon-end or the apical-end. It also is in the tissues between the vascular ring and the tuber surface. Discoloured tissue near the surface makes the skin appear dark, but generally there are no external symptoms. The Standard does not regulate internal defects, other than rot which most often shows externally.

Hollow heart, (App. 1: Pic. 10) or hollow heart with discolouration (Pic.11), is a condition brought about by too rapid or irregular growth. The precursor may be a light brown discolouration. Hollow heart exists in the form of cavities of varying size. They may be lined with light-brown to brown dead tissues.

- Not countable.

Internal potato necrosis (not net necrosis) is caused by alfalfa mosaic virus. The tissue under the skin has a rusty-brown colour in patches starting at the stolon-end similar to late blight infections. The discoloured areas may later extend throughout the potato. Potatoes apparently clean at harvest may show discolouration after six weeks of storage without a definite pattern of internal discolouration. It may be dry, brown blotches in pockets but also in loops and half-circles. In suspected lots of potatoes a true estimate of potato necrosis damage can be obtained only by cutting.

- Not countable.

Net necrosis (App. 1: Pic. 12) is the presence of a network of necrotic strands brown to brownish-black in colour and sometimes extending throughout the flesh of the potato. It may be caused by the Potato Leaf Roll Virus (PLRV).

- Not countable.

Spraing (TRV (Page 55), or PMTV (Page 51))

Tubers may develop spraing: arcs of red-brown necrotic tissue through the tuber flesh. Spraing is usually associated with TRV or PMTV.

- Not countable.

Stem-end browning (App. 1: Pic 13) occurs as dark-brown to black streaks or areas that can be detected by cutting off the stolon-end. It may have a chemical cause but it also may be the beginning of net necrosis.

- Not countable.

Vascular discolouration (App.1 Pic: 14) shows a clearly discoloured vascular ring mostly at the stolon-end. Any evidence of bacteria is grounds for laboratory diagnosis.

- Not countable
- Where bacterial disease is suspected laboratory diagnosis is needed to confirm the absence of any regulated organisms

15. Dry rot, wet rot and wet breakdown

15.1 Rot

Rot is the disintegration of tissue as a result of the action of invading organisms, usually bacteria or fungi. Rot can be triggered by environmental factors. A tuber rot may be classified as either “wet” rot (also called “soft” rot) or “dry” rot according to its external and internal appearance. All affected tubers are countable.

15.2 Wet rot (e.g. Page 67)

Tuber softening to maceration, associated with a fluid exudate, which has arisen due to a primary or secondary bacterial and/or fungal infection. The tolerances for wet rot (not caused by pests listed under section B in appendix 1 of the Standard), including wet breakdown (App.1 Pic: 15) due to extreme temperatures are:

15.3 Dry rot (e.g. Page 17)

Tuber tissue exhibiting a sunken, necrotic lesion without the loss of fluid exudates, which may remain localized or enlarge by becoming wrinkled and mummified to encompass the whole tuber.

15.4 Rot tolerances

The rot tolerance is a combined tolerance where the total allowable presence of any rots, whether dry or wet rot, is specified. A stricter tolerance for all wet rots permitted within the overall total is also specified.

Tolerances:

Dry and wet rot not caused by zero tolerance pests, including wet breakdown due to extreme temperatures

- Pre-basic TC 0 per cent by weight
- Pre-basic 0.2 per cent by weight
- Basic and Certified l per cent by weight, of which wet rot cannot exceed 0.5 per cent

15.5 List of diseases and disorders causing rot symptoms

Alternaria tuber rot (Early blight, ***Alternaria* spp**.) (page 13) is a dry rot. It occurs as lesions of irregular size and shape, brown to purplish-brown, slightly sunken with irregular borders. Alternaria tuber rot occurs in potatoes harvested during cool humid weather. The

infection opens the way for secondary infections by species of *Fusarium* and other organisms. Alternaria may develop a dry rot.

- Rot tolerances apply, counted as dry rot.

Bacterial ring rot (*Clavibacter michiganensis ssp. sepedonicus*) (Page 65) may be in potatoes that appear healthy or have dark discolorations under the skin at the stolon-end or under the eyes. The tubers may show a characteristic cracking not deeper than the vascular ring. The vascular ring and surrounding tissue may be pale-yellow or glassy becoming darker. The rot is odourless and cheesy or crumbly. Rotting may later extend into the central pith. Upon cutting the potato near the stolon-end the vascular ring may show a yellowish-white or light-brown discolouration. This may involve the entire ring or only isolated portions of it. The infected tissue is often crumbly in consistency and may ooze from the freshly cut surface if the potato is squeezed. Infected potatoes may be apparently healthy at digging time and develop symptoms in storage.

Bacterial ring rot potatoes are very susceptible to secondary infection, especially by soft rot organisms. Affected tubers show various stages of decay up to complete disintegration. With secondary infection, there is often a distinctive separation between the portions of the potato inside and outside of the vascular region; the outer layer can be broken off like a shell.

- Zero tolerance for bacterial ring rot.

Blackleg tuber rot (*Dickeya / Pectobacterium spp*) (Page 67) is a wet rot of soft brownish-white rot extending from the stolon-end or lenticels. Affected area has a dark margin. It produces a distinctive fishy smell. Decayed potatoes may be white or only slightly coloured and cheesy or buttery in consistency but gradually turn black and slimy as the decomposition progresses. In storage it is typical for blackleg to be confined to the centre of the potato, which becomes hollowed and black with a layer of slimy lining. The tolerances are as for wet rot:

- Rot tolerances apply, counted as wet rot.

Brown rot /Bacterial wilt *(Ralstonia solanacearum*) (Page 69) is a wet rot. Starts with a creamy colour at the stolon-end progressing to a brown staining of the vascular ring. The disease is sometimes indicated by sunken spots at the stem, or by grey-coloured spots on the surface. As the disease progresses the vascular tissue rots away completely and pale-coloured, milky, sticky ooze may appear at the eyes, lenticels, and/or stolon-end of the tuber to which soil may adhere.

Frequently there are no external indications. The presence of the defect may be determined only by cutting the potatoes. At more advanced stages this disease is frequently followed by slimy soft rot.

- Zero tolerance for brown rot.

Fusarium tuber rot (Page 17) is usually dry at low temperatures and wet at high temperatures. It is never slimy even when wet and never has a bad odour unless accompanied by other fungi or bacteria.

There are several different species of *Fusarium* with slightly different symptoms: generally dry rots develop around an initial wound dehydrating the tuber.

- *F. solani* var. *coeruleum*: Circular rot with concentric wrinkles and white, orange or blue mycelial growth on the surface. Light-brown rot with a diffuse edge develops from the skin inwards.

- *F. sulphureum*: Small lesions develop at wounds and expand producing symptoms externally similar to gangrene, i.e. slightly depressed and of irregular shape. Internally lesions develop cavities filled with grey powdery tissue.
- *F. avenaceum*: Symptoms tend to be similar to *F. solani* var. *coeruleum*, although rots are often smaller and affected tissue is dark-brown.

Do not confuse infections of multi-coloured starchy moulds with Fusarium tuber rot. These starchy moulds, commonly misidentified as Fusarium, often appear either alone or in conjunction with Fusarium as they also enter the potato through injuries, cuts and bruises. The rot may be dry and brittle, wet and jelly-like or even mushy and leaky.

If the entire decayed area is so dry that no moisture appears when squeezed, or is only slightly moist, it should be reported as "dry rot."

- Rot tolerances apply, counted as dry rot.

Jelly end-rot is identified by its jelly-like, watery consistency occurring at the stolon-end of the potato, second growth knobs or pointed ends. This disorder is caused by conditions that interfere with the deposition of starch in the growing tissues. There is some evidence that fluctuations in moisture supply during the growing season may be responsible. Jelly end-rot often dries leaving a shrivelled flaky area. The tolerances are:

- In the mushy, leaky stage the rot tolerances apply, counted as wet rot.
- Otherwise countable as misshapen with a tolerance for external defects (e.g. misshapen or damaged tubers): 3% by weight for all categories.

Late blight tuber rot *(Phytophthora infestans*) (page 29). A tuber infection will show up as a darker-brown, sometimes purplish, area on the tuber surface. The internal rot is a reddish-brown granular rot which can remain close to the surface or progress to the centre of the tuber. Rot development is irregular without a distinct leading edge and can be threadlike.

Affected tubers often have firm flesh with brown areas but secondary infection can lead to wet breakdown of the tubers.

- Rot tolerances apply, counted as wet rot or dry rot.

Leak tuber rots (***Pythium spp***.) (Page 33) develop at wounds soon after harvest when growing conditions are hot. Tubers are discoloured with a greasy feel. Rots develop in the flesh of tuber with a clear dark line separating healthy outer tissue from spongy, soft brown diseased tissue which turns dark on exposure to air. Rotten tissue initially smells alcoholic but once advanced smells fishy.

- Rot tolerances apply, counted as wet rot

Pink rot *(Phytophthora erythroseptica)* (Page 25) may develop in the tubers at lenticels and eyes soon after harvest when conditions have been wet and warm just before harvest. Tubers are rubbery, usually affected at the stolon-end. Affected tissue turns pink on exposure to air within an hour. Tubers can have a distinctive sweet smell and ooze a colourless clear liquid if squeezed hard.

Rot tolerances apply, counted as wet rot

Sclerotinia rot (White mould, *Sclerotinia sclerotiorum*) (Page 37). Internally the rot is pale-brown with fluffy white mycelia and black sclerotia developing in cavities. Sometimes tubers may have a stolon-end rot. Depending on the stage of the decay, rot may turn into wet rot.

- Rot tolerances apply, counted as wet rot or dry rot.

Wet breakdown. (App. 1, pic. 15) Upon thawing, potatoes exhibit wet leaking known as wet breakdown.

- Rot tolerances apply, counted as wet rot.

16. Calculation of results

During the inspection process a tuber should only be counted once for a defect or damage. The defect most likely to lead to the rejection of the lot will be counted.

Examples

Consider a basic category seed lot where powdery scab and pest damage are present in the inspected sample;

Example A: The inspector finds 0.3% of tubers with powdery scab and 2% pest damage, in addition 0.8% of tubers have both pest damage and powdery scab. Only one type of fault may be counted per tuber. Where tubers have both pest damage and powdery scab, the inspector needs to decide which fault to count. In this example, the inspector should count the 0.8% tubers with both faults as powdery scab since this takes the lot to 1.1% for powdery scab which is over the tolerance of 1%. Otherwise, the total of all tubers with pest damage is 2.8% which is less than the tolerance (4%) for pest damage.

Example B: Another lot has a similar mixture of faults where the inspector finds 0.1% of tubers with powdery scab and 3.5% pest damage, in addition 0.6% of tubers have both pest damage and powdery scab. Only one type of fault may be counted per tuber. Where tubers have both pest damage and powdery scab, the inspector needs to decide which fault to count. In this example, the inspector should count pest damage as this take the total pest damage to 4.1% which is over tolerance (4%) for pest damage. Otherwise, the total of all tubers with powdery scab is 0.7% which is less than the tolerance (1%) for powdery scab.

The DA may wish to record the incidence or total score of individual faults for epidemiological reasons. Where faults are seen at the inspection, their presence should be noted even if only seen on tubers where another fault is counted.

17. Additional measures

If the sample exceeds the tolerance for any of the categories, an inspector may allow re-grading of the lot. This does not apply when the symptoms of a zero tolerance pest have been observed. Where the inspection result is borderline the inspector may proceed to take additional samples to confirm the result of the inspection.

18. Second-opinion inspections

In the case of a disputed inspection, growers will be entitled to ask for a confirmatory inspection to be conducted by another inspector.

References

- UNECE STANDARD S-1, concerning the marketing and commercial quality control of Seed Potatoes. 2014 Edition.
- UNECE Guide to Seed Potato Diseases, Pests and Defects, 2014.

- UNECE Guide to Seed Potato Field Inspection: Recommended practices, 2014.
- Shipping Point and Market Inspection Instructions (USDA, April 2012).

Defects not in "UNECE Guide to Seed Potato Diseases, Pests and Defects, 2014"

Note: The following defects will be demonstrated with photos once agreed.

1 Caked Dirt (NDSSD)

2 Air Cracks (NDSSD)

3 Elephant Hide (NDSSD)

4 Enlarged Lenticels (NDSU/UM)

5 Grass root symptoms (USDA)

6 Grub Damage (USDA)

7 Pink Eye (NDSSD)

8: Russet Scab (NDSSD)

9: Black Heart (NDSSD)

10: Hollow Heart (NDSSD)

11: Hollow Heart with discoloration (NDSSD)

12: Net Necrosis (NDSSD)

13 Stem End Browning (USDA)

14 Vascular Discolouration (USDA)

15. Jelly End Rot (SA PCS)

16. Jelly End Rot (SA PCS)

17 Wet Breakdown

Examples of sealing methods for bulk containers

Note: The following defects will be demonstrated with photos once agreed.

1. Use of a numbered tamper evident seal to close a bulk vehicle.
2. Use of tamper evident seals to close the doors of a bulk vehicle.
3. Use of tamper evident seals to close the rear and sides of a bulk vehicle.
4. Use of tamper evident seal to close the tailgate of a vehicle carrying bulk bins.