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Seedling evaluation of *Glycine max*

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GER COMMITTEE	GER COMMITTEE MEMBERS	GER COMMITTEE CHAIR

Scope

The scope of this document is to explain the procedure for the correct evaluation of *Glycine max*.
This guideline will have future revisions in order to keep in force the ISTA seedling evaluation criteria.

Related Document

ISTA Rules

ISTA Handbook on Seedling Evaluation

Responsibilities

This work was developed with different opinions, experience, and point of view of several seed technicians of Argentina and Members of the ISTA Germination Committee.

The aim of this work is to provide a new tool for the correct evaluation of *Glycine max* according to the criteria of the ISTA Rules and the ISTA Handbook on Seedling Evaluation.

ABBREVIATIONS

n.a

Introduction

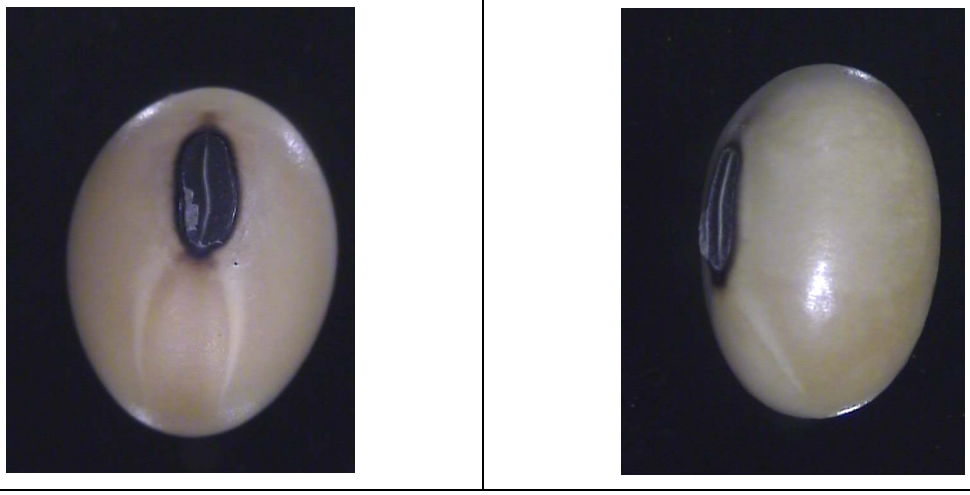


Figure 1: Different views of the dried seed

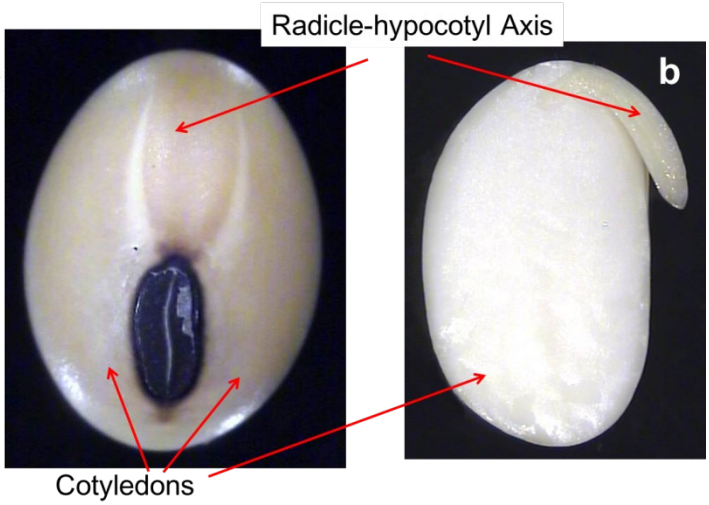


Figure 2:

a) Whole dried seed;
b) Hydrated seed longitudinal section

Figure 3: Development of the normal seedling during the test period.

In rolled paper towels, the seedlings show a delay in development in comparison to sand; and usually the primary leaves remain longer enclosed in the cotyledons as shown in figure 4 and 5.

Figures 4 and 5: Development of the seedling in rolled paper towels.

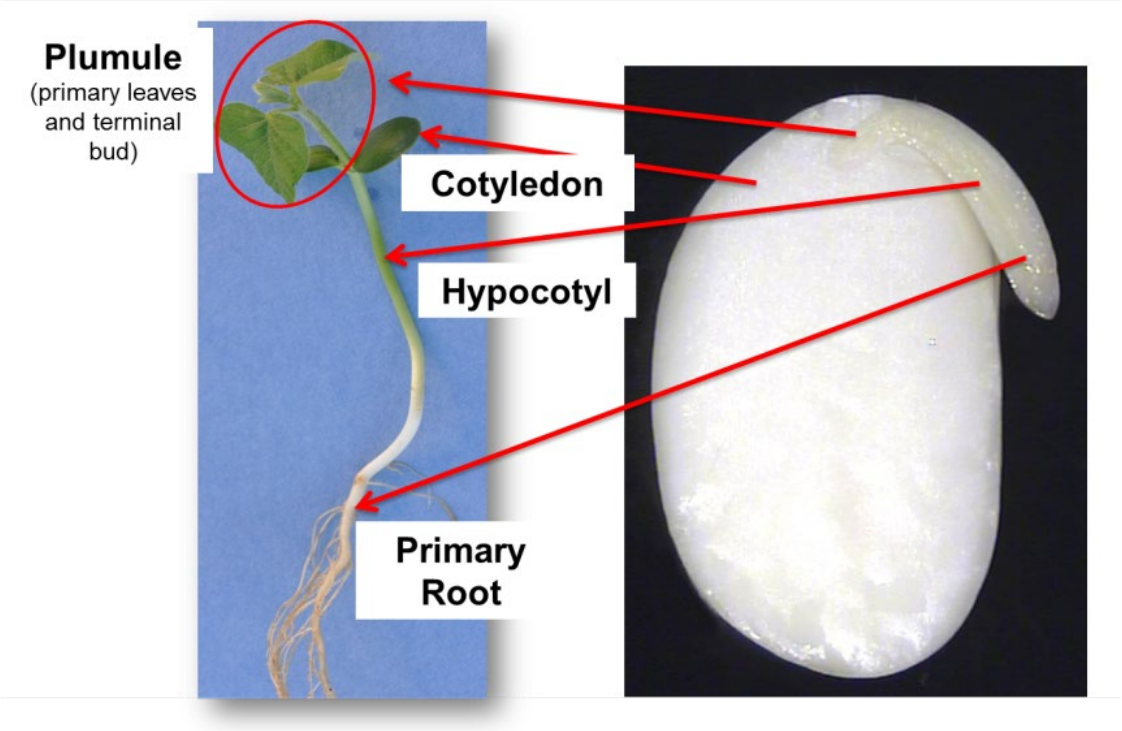


Figure 6: Correspondence of structures (seed – seedling)

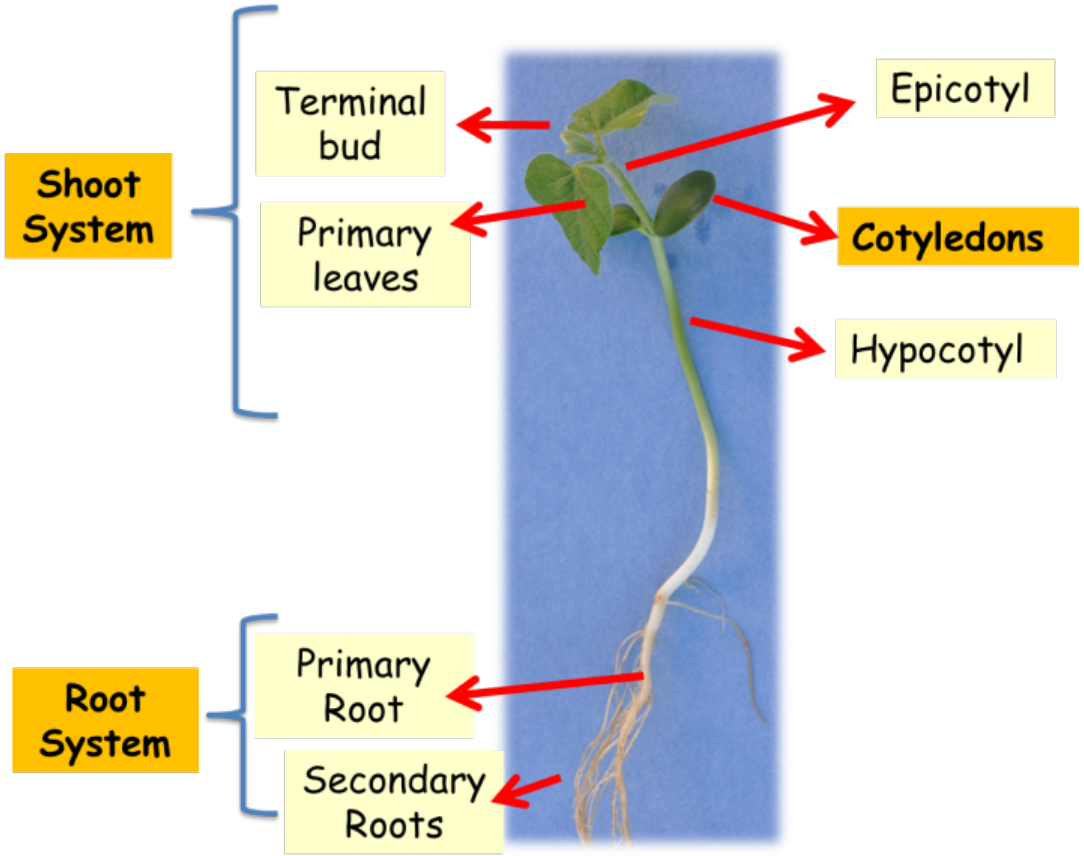
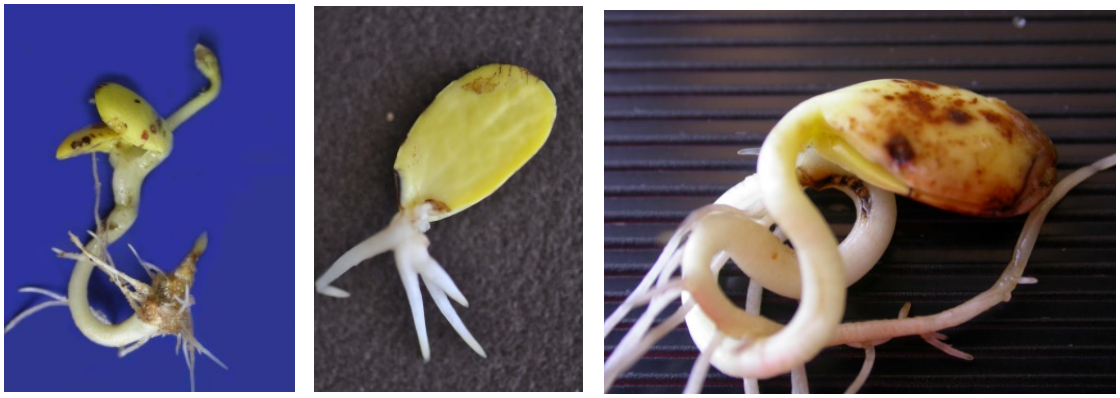


Figure 7: Normal seedling structures

Overall abnormalities

Figure 8: 00/03 The seedling releases the cotyledons before the primary root from the seed coat.

Figure 9: 00/10 The seedling shows phytotoxic symptoms.



Figures 10, 11 and 12: 00/01 The seedling is deformed.

Figure 13: 00/02 The seedling is fractured.

Figure 14: 00/11 The seedling is unbalanced.

Figure 15: 00/04 The seedling consists of fused twin seedlings.

Root system

During the test period, the normal seedling has a primary root, usually with several secondary roots. In this specie, if the primary root is defective, secondary roots can replace a defective primary root and the seedling can be classified as normal if these criteria are met:

A seedling with a defective primary root is classified as normal, when a **sufficient number** of normal secondary roots have developed as long as all the following conditions are met:	*a) At least 3 secondary roots which do not show any defect listed for primary root should be present.* *b) These secondary roots should be equal to or greater than half of the length of the hypocotyl.* *c) In seedlings with under developed hypocotyls, the hypocotyl and each secondary root should have at least an equal length as the major axis of the cotyledon.*

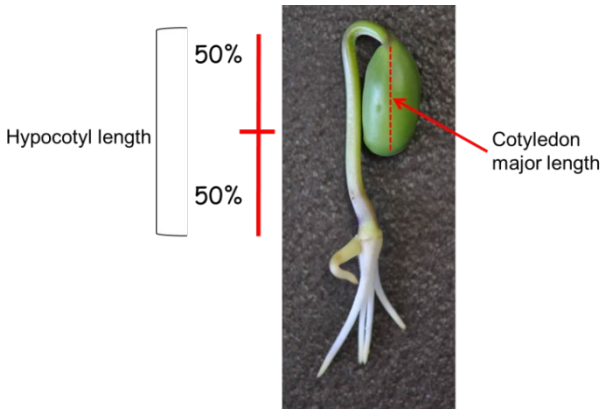
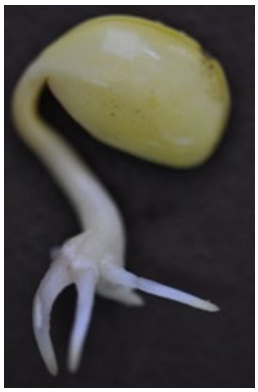


Figure 16: Cotyledon and hypocotyl length proportion.

a	Yes
b	Yes
c	Yes

Figures 17 and 18: Normal seedlings.

a	Yes
b	No
c	No



Figures 19 and 20: Abnormal seedlings.

a	No
b	No
c	No

Figure 21: Abnormal seedling.

Abnormalities of the root system

Figure 22: 11/08 Roots show negative geotropism.

Figure 23: 11/07 The primary root is trapped in the seed coat.

Figures 24, 25 and 26: 11/04 The primary root is missing.

Figures 27, 28 and 29: 11/01 The primary root is stunted.

Figure 30: 11/12 The primary root is decayed as a result of primary infection.

Figure 31: 11/06 The primary root is split from the tip or split right through.

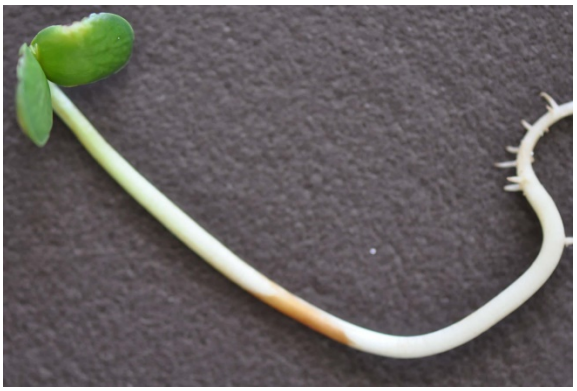
Figure 32: Stubby roots compared with normal roots.

Figure 33: 11/05 The primary root is deeply cracked or broken.

Figure 34: 11/09 The primary root is constricted.

Shoot System
Abnormalities of the hypocotyl and epicotyl

Figure 35: 21/01 The hypocotyl is short and thick.	Figure 36: 21/01 The hypocotyl is short and thick.

	
Figure 37: 21/09 The hypocotyl is constricted.	Figure 38: 21/12 The hypocotyl is decayed as result of primary infection.

Note: On figure 38, for a correct evaluation, the analyst must determine by cutting through the depth of the infection.

Figures 39 and 40: 21/03 The hypocotyl is deeply cracked or broken.

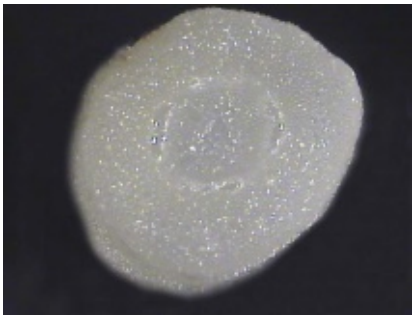
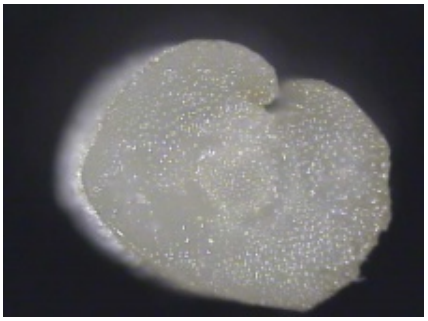
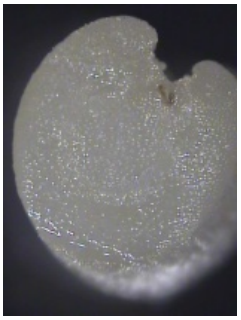
Figure 41: Deeply cracked or broken hypocotyl (Normal Seedling).

Figure 42: 21/03 The hypocotyl is deeply cracked or broken (Abnormal Seedling).

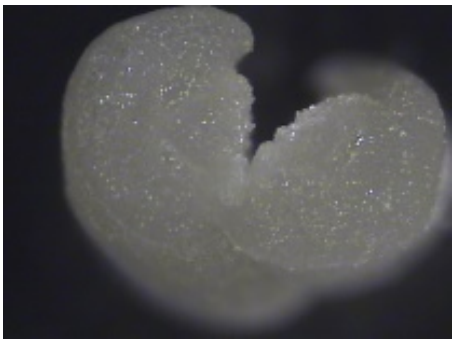
Note: On figure 41, healed breaks are considered normal provided the conductive tissue is not disrupted. For a correct evaluation of cracks, the analyst must determine if the conductive tissue is disrupted or not (See Point 8.4.3, ISTA Handbook on Seedling Evaluation).

Figures 43, 44 and 45: 21/04 The hypocotyl is split right through (The split reaches the central cylinder).

Figures 46 and 47: 21/04 The hypocotyl is split right through (split reaches the central cylinder).

Figures 48, 49 and 50: Normal seedling (split does not reach the central cylinder).



Figures 51 and 52: Abnormal seedling (split reaches the central cylinder).

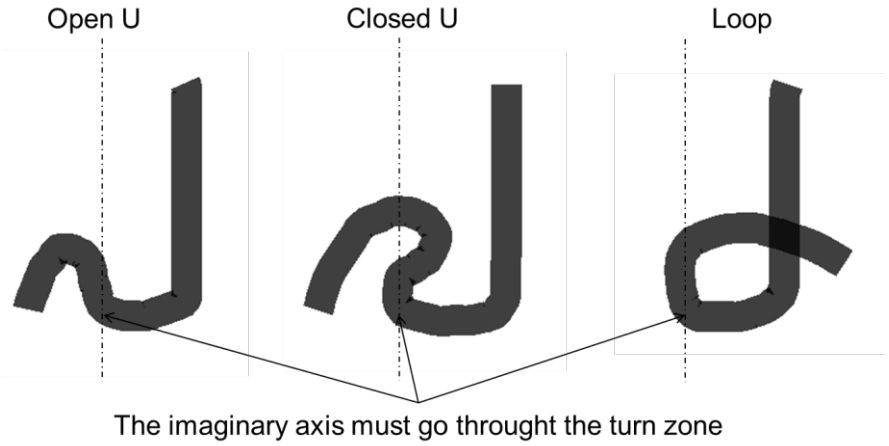
Note: For a correct evaluation of the splits, see Point 8.4.3, ISTA Handbook on Seedling Evaluation.

Loops (curvatures at the base of the hypocotyl):

- If the LOOP is forming an open U, the seedling is considered as NORMAL.

- If the LOOP is forming a closed U:
  - Without primary root defect, the seedling is considered NORMAL.
  - With primary root defect, the seedling is considered ABNORMAL.

- If it is forming a complete LOOP, the seedling is considered ABNORMAL.



Figures 53, 54 and 55: show the criteria to be applied to evaluate the loops.

Note: Rolled and folded towel test conditions can cause the "Closed U" and the "Loop" due to restricted growing conditions between the towel layers. For a correct evaluation, the analyst must determine if the "Closed U" or the "Loop" was caused by a true defect or by a test condition.

Figure 56: 21/07 The hypocotyl forms a spiral.	Figure 57: 21/08 The hypocotyl is tightly twisted.

Figure 58: 21/12 The epicotyl is decayed as a result of primary infection.	Figure 59: 21/06 The epicotyl is bent over.

Figure 60: Epicotyl bent over and with damage in the point of attachment of the cotyledons.

Figure 61: 21/13 The hypocotyl shows negative phototropism.

Abnormalities of the terminal bud and/or surrounding tissues

Figure 62: 22/03 The terminal bud is missing.

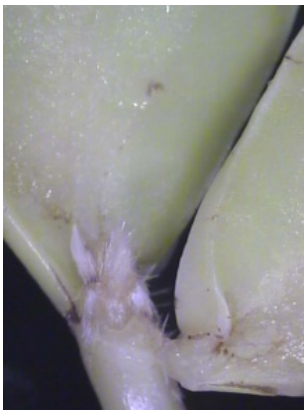


Figure 63: 22/02 The terminal bud is damaged.

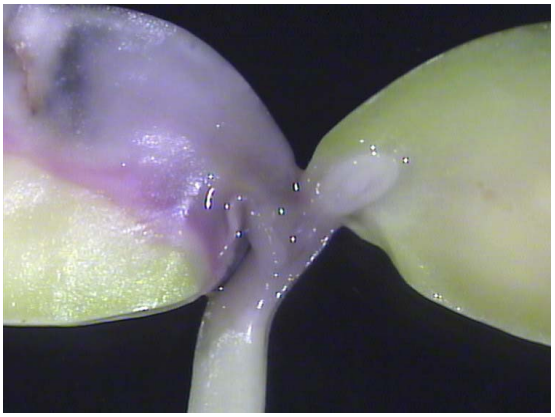


Figure 64: 22/05 The terminal bud and the surrounding tissues are decayed as a result of primary infection.

Figure 65: 22/03 and 22/05 The terminal bud is missing and the surrounding tissues are decayed as a result of primary infection.

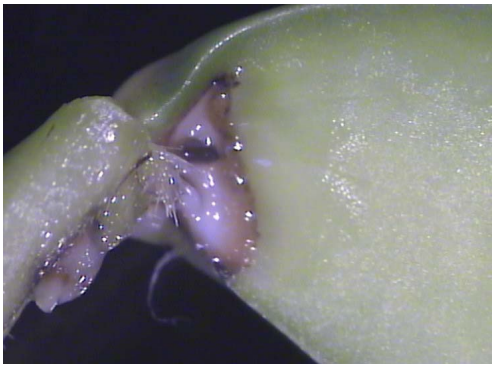


Figure 66: 22/05 The terminal bud and the surrounding tissues are decayed as a result of primary infection.

Abnormalities of the cotyledons

In this structure, the 50% Rule must be applied for the following defects:

- Missing tissue
- Necrotic tissue
- Discoloured tissue
- Decayed tissue

Figure 67: 31/04 Cotyledons are missing.	Figure 68: 31/04 Cotyledons are missing.

Figure 69: 31/07 Cotyledons are decayed as a result of primary infection.	Figure 70: 31/07 and 22/01 Cotyledons are decayed as a result of primary infection and the terminal bud is deformed.

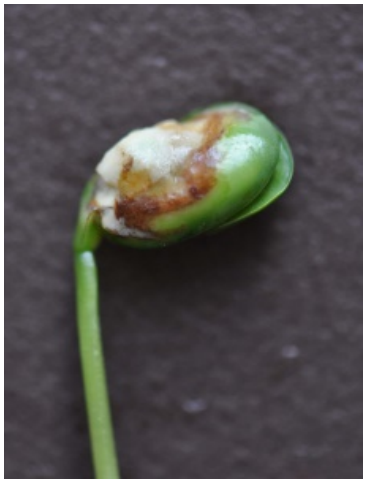


Figure 71: 31/07 Cotyledons are decayed as a result of primary infection.

Figure 72: 31/07 Cotyledons are decayed as a result of primary infection.

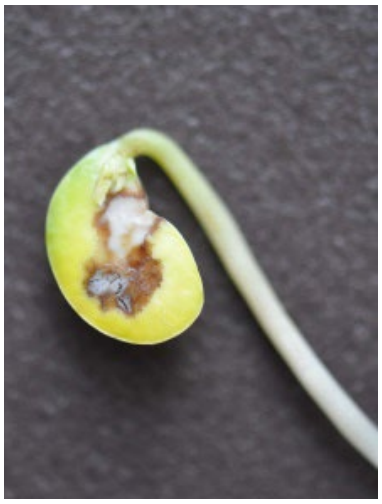


Figure 73: 31/07 and 22/03 Cotyledons are decayed as a result of primary infection and the terminal bud is missing.

Figure 74: Cotyledons are damage at the two points of attachment (Abnormal seedling).	Figure 75: Cotyledons are damage at the two points of attachment (Abnormal seedling).

Figure 76: 31/03 Cotyledons are broken.	Figure 77: 31/03 Cotyledons are broken.

Figure 78: 31/05 Cotyledons are necrotic.

Figures 79 and 80: 31/02 Cotyledons are deformed.

Abnormalities of the primary leaves

In this structure, the 50% Rule must be applied for the following defects:

- Missing tissue
- Necrotic tissue
- Discoloured tissue
- Decayed tissue

Figure 81: 33/03 and 33/07 One primary leaf is missing and the other one is decayed as a result of primary infection (Combination of two types of abnormalities).	Figure 82: 33/07 Primary leaves are decayed as a result of primary infection.

Deformed primary leaves (curled leaves)

Figures 83 and 84: Deformed primary leaves.

If at the end of the prescribed test period, several primary leaves are deformed as shown in figures 83 and 84, it is highly recommended to extend the test period up to 7 more days.

At the end of the extended test period these situations can occur:

1. Deformed leaves end up necrotic (Abnormal seedling).
2. Leaves remain deformed (Abnormal seedling)
3. Deformed leaves end up being normal expanded leaves and the seedling continues its development (Normal seedling).

Note: A slight thickening of the base of the hypocotyl can occur in addition with these three situations (The seedling will be classified as Abnormal or Normal depending on the situation 1, 2 or 3).

ANNEX

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DISTRIBUTION LIST

ISTA website

REVISION HISTORY

Version #	Changes
2.0	Layout change