

Requirement specification

Computer image analysis system (software + hardware) for advanced automatic analysis of various leaf, seed/needle and root properties

Software and associated technical equipment for leaf, seed, needle and root measurements

The software + technical equipment (e.g. scanners, leaf presses, camera stands) should enable accurate, detailed and automatic measurements of various leaf-, seed/needle- and root morphological properties and pest and pathogen damage quantification. The software should be able to handle data from digital cameras and scanners, the latter for increased accuracy regarding colour and morphological measurements.

Minimum specific requirements for leaf analysis software:

The software needs to be able to automatically measure leaf parameters and provide data such as:

Requirements	Software has this property YES/NO	Description and/or reference to appendix
Leaf area (preferably both total area of several leaves scanned, and the area of each leaf separately).		
Blade area		
Total leaf length + blade and petiole length separately		
Leaf width (maximum and average)		
Leaf and blade perimeter		
Colour analysis (area per colour for disease measurement)		
Area and numbers of holes/discoloring (insect or pest damage, or even actual insects/mites), both total and individual		

Other automatic or manual functions that is desirable for this software:

Requirements	Software has this property YES/NO	Description and/or reference to appendix
Aspect ratio (elongation factor)		
Form coefficient		
Envelope area (area between teeth)		
Teeth height, width and count		
Fractals (for leaf shape analysis)		
Blade width at user definable positions		
Lobe angle at user definable positions		
Lengths and angles		
Measurements of user defined areas		

There is also a need to be able to classify leaves in predefined categories (manually) based on percentage of holes or discoloring (insect damage or diseases) to categorize high numbers of leaves automatically.

Minimum specific requirements for seed and needle analysis software:

The software needs to be able to automatically measure seed and needle parameters and provide data such as:

Requirements	Software has this property YES/NO	Description and/or reference to appendix
Length		
Width		
Area		
Colour classification (very subtle colour differences should be able to be detected)		
Area per colour		
Group needles/seeds based on colour		
Disease/pest damage quantification		

Other automatic or manual functions that is desirable for this software:

Requirements	Software has this property YES/NO	Description and/or reference to appendix
Volume		
Sort data into user defined classes (e.g. diameter)		
Measurements of user defined areas		

Minimum specific requirements for root analysis software:

The software needs to be able to automatically measure root parameters and provide data, such as:

Requirements	Software has this property YES/NO	Description and/or reference to appendix
Length		
Diameter		
Area		
Volume		
Number of tips		
Link analysis		
Topology data		
Architecture		
Colour analysis		

Other automatic or manual functions that is desirable for this software:

Requirements	Software has this property YES/NO	Description and/or reference to appendix
Provide root morphology data as a function of diameter or colour		
Automatic adjustment for overlapping roots		
Provide data from all scanned objects + nontouching objects individually		
Width and length of seedlings (roots+ first leaves)		
Sort data into user defined classes (of for example diameter)		
Measurements of user defined areas		

Associated technical equipment (hardware) needed (shared for all analyses software described above):

Technical equipment that enables measurements (data acquisition) both in field and lab (hence portability is required).

Specific needs:

Requirements	Equipment has this property YES/NO	Description and/or reference to appendix
Three scanners to be used in field and/or laboratory and compatible with the requirements specified under the software above		
Three leaf presses of various sizes, in the range approximately 12"x16" to 27"x36".		
Two different camera stands with arms fitting the three leaf presses		
Three calibration kits to be used in the imaging/scanning operation to enable automatic size and spectral calibration of the measured object properties		
Positioning and lighting systems for seeds, needles and roots to enable accurate scanning and avoid shadows		