

Appendix 1 : List of the 587 species of the leaf dataset

<i>Abelia</i> × <i>grandiflora</i>	<i>Berberis anhweiensis</i>	<i>Citrus</i> × <i>aurantium</i>	<i>Eucommia ulmoides</i>
<i>Abies alba</i>	<i>Berberis aquifolium</i>	<i>Citrus japonica</i>	<i>Euonymus alatus</i>
<i>Abies balsamea</i>	<i>Berberis julianae</i>	<i>Citrus limon</i>	<i>Euonymus europaeus</i>
<i>Abies concolor</i>	<i>Berberis thunbergii</i>	<i>Citrus trifoliata</i>	<i>Euonymus fortunei</i>
<i>Abies grandis</i>	<i>Berberis vulgaris</i>	<i>Clematis flammula</i>	<i>Euonymus sachalinensis</i>
<i>Abies homolepis</i>	<i>Betula alba</i> subsp.	<i>Clematis montana</i>	<i>Euonymus verrucosus</i>
<i>Abies koreana</i>	<i>papyrifera</i>	<i>Clematis vitalba</i>	<i>Euphorbia pulcherrima</i>
<i>Abies lasiocarpa</i>	<i>Betula alleghaniensis</i>	<i>Clematis viticella</i>	<i>Excoecaria</i>
<i>Abies nordmanniana</i>	<i>Betula alnoides</i>	<i>Clerodendrum</i>	<i>cochinchinensis</i>
<i>Abies pinsapo</i>	<i>Betula costata</i>	<i>trichotomum</i>	<i>Exochorda racemosa</i>
<i>Abies procera</i>	<i>Betula dahurica</i>	<i>Clethra alnifolia</i>	subsp. <i>giraldii</i>
<i>Abies veitchii</i>	<i>Betula ermanii</i>	<i>Clinacanthus nutans</i>	<i>Fagus grandifolia</i>
<i>Acer buergerianum</i>	<i>Betula insignis</i>	<i>Colutea arborescens</i>	<i>Fagus orientalis</i>
<i>Acer campestre</i>	<i>Betula lenta</i>	<i>Coris monspeliensis</i>	<i>Fagus sylvatica</i>
<i>Acer cappadocicum</i>	<i>Betula maximowicziana</i>	<i>Cornus alba</i>	<i>Fallopia aubertii</i>
<i>Acer carpinifolium</i>	<i>Betula nana</i>	<i>Cornus controversa</i>	<i>Ficus benjamina</i>
<i>Acer caudatum</i>	<i>Betula nigra</i>	<i>Cornus florida</i>	<i>Ficus carica</i>
<i>Acer circinatum</i>	<i>Betula pendula</i>	<i>Cornus kousa</i>	<i>Firmiana simplex</i>
<i>Acer coriaceifolium</i>	<i>Betula populifolia</i>	<i>Cornus mas</i>	<i>Flemingia strobilifera</i>
<i>Acer davidii</i>	<i>Betula utilis</i> var.	<i>Cornus nuttallii</i>	<i>Forsythia</i> × <i>intermedia</i>
<i>Acer griseum</i>	<i>jacquemontii</i>	<i>Cornus sanguinea</i>	<i>Frangula alnus</i>
<i>Acer japonicum</i>	<i>Bougainvillea glabra</i>	<i>Cornus sericea</i>	<i>Fraxinus excelsior</i>
<i>Acer macrophyllum</i>	<i>Bougainvillea spectabilis</i>	<i>Coronilla juncea</i>	<i>Fraxinus latifolia</i>
<i>Acer mandshuricum</i>	<i>Broussonetia papyrifera</i>	<i>Corylopsis spicata</i>	<i>Fraxinus ornus</i>
<i>Acer monspessulanum</i>	<i>Brunfelsia pauciflora</i>	<i>Corylus avellana</i>	<i>Fraxinus paxiana</i>
<i>Acer negundo</i>	<i>Buddleja</i> × <i>weyeriana</i>	<i>Corylus colurna</i>	<i>Fumana ericifolia</i>
<i>Acer opalus</i>	<i>Buddleja davidii</i>	<i>Corylus maxima</i>	<i>Fumana laevipes</i>
<i>Acer palmatum</i>	<i>Buddleja globosa</i>	<i>Cotinus coggygria</i>	<i>Fumana thymifolia</i>
<i>Acer pensylvanicum</i>	<i>Buxus sempervirens</i>	<i>Cotoneaster floccosus</i>	<i>Fumana viridis</i>
<i>Acer platanoides</i>	<i>Callicarpa dichotoma</i>	<i>Cotoneaster frigidus</i>	<i>Gaultheria procumbens</i>
<i>Acer pseudoplatanus</i>	<i>Calycanthus floridus</i>	<i>Cotoneaster horizontalis</i>	<i>Ginkgo biloba</i>
<i>Acer rubrum</i>	<i>Camellia sasanqua</i>	<i>Cotoneaster integerrimus</i>	<i>Gleditsia triacanthos</i>
<i>Acer rufinerve</i>	<i>Campsis radicans</i>	<i>Cotoneaster multiflorus</i>	<i>Globularia alypum</i>
<i>Acer saccharinum</i>	<i>Cananga odorata</i>	<i>Crataegus</i> × <i>lavallei</i>	<i>Graptophyllum pictum</i>
<i>Acer saccharum</i>	<i>Caragana arborescens</i>	<i>Crataegus laevigata</i>	<i>Gymnocladus dioica</i>
<i>Acer sempervirens</i>	<i>Carpenteria californica</i>	<i>Crataegus mollis</i>	<i>Halesia carolina</i>
<i>Acer tataricum</i>	<i>Carpinus betulus</i>	<i>Crataegus monogyna</i>	<i>Halesia tetraptera</i> var.
<i>Actinidia arguta</i>	<i>Carpinus caroliniana</i>	<i>Crataegus nigra</i>	<i>monticola</i>
<i>Actinidia deliciosa</i>	<i>Carpinus japonica</i>	<i>Crataegus pedicellata</i>	<i>Halimodendron</i>
<i>Actinidia kolomikta</i>	<i>Carya illinoensis</i>	<i>Crataegus pinnatifida</i>	<i>halodendron</i>
<i>Aesculus</i> × <i>carnea</i>	<i>Carya ovata</i>	<i>Crataegus sanguinea</i>	<i>Hamamelis</i> × <i>intermedia</i>
<i>Aesculus chinensis</i>	<i>Castanea sativa</i>	<i>Crataegus succulenta</i>	<i>Hamamelis virginiana</i>
<i>Aesculus flava</i>	<i>Catalpa bignonioides</i>	<i>Crataemespilus</i>	<i>Hedera helix</i>
<i>Aesculus glabra</i>	<i>Catalpa ovata</i>	<i>grandiflora</i>	<i>Helianthemum hirtum</i>
<i>Aesculus hippocastanum</i>	<i>Ceanothus americanus</i>	<i>Cryptomeria japonica</i>	<i>Helichrysum stoechas</i>
<i>Aesculus</i> × <i>mutabilis</i>	<i>Ceanothus</i> × <i>delilianus</i>	<i>Cunninghamia lanceolata</i>	<i>Heptacodium miconioides</i>
<i>Aesculus</i> × <i>neglecta</i>	<i>Cedrus deodara</i>	<i>Cydonia oblonga</i>	<i>Hibiscus rosa-sinensis</i>
<i>Aesculus parviflora</i>	<i>Cedrus libani</i>	<i>Cytisus scoparius</i>	<i>Hibiscus syriacus</i>
<i>Aesculus pavia</i>	<i>Celtis australis</i>	<i>Danae racemosa</i>	<i>Holodiscus discolor</i>
<i>Aesculus turbinata</i>	<i>Celtis occidentalis</i>	<i>Daphne mezereum</i>	<i>Hovenia dulcis</i>
<i>Ailanthus altissima</i>	<i>Centratherum punctatum</i>	<i>Dasiphora fruticosa</i>	<i>Humulus lupulus</i>
<i>Akebia quinata</i>	<i>Cephalanthus occidentalis</i>	<i>Davidia involucrata</i>	<i>Hydrangea arborescens</i>
<i>Alangium platanifolium</i>	<i>Cephalaria leucantha</i>	<i>Decaisnea insignis</i>	<i>Hydrangea macrophylla</i>
<i>Allamanda cathartica</i>	<i>Cephalaria leucantha</i>	<i>Deutzia gracilis</i>	<i>Hydrangea paniculata</i>
<i>Alnus alnobetula</i>	<i>Cephalotaxus sinensis</i>	<i>Deutzia hybrida</i>	<i>Hydrangea petiolaris</i>
<i>Alnus cordata</i>	<i>Ceratonia siliqua</i>	<i>Deutzia longifolia</i>	<i>Hydrangea quercifolia</i>
<i>Alnus glutinosa</i>	<i>Cercidiphyllum japonicum</i>	<i>Deutzia scabra</i>	<i>Hypericum androsaemum</i>
<i>Alnus incana</i>	<i>Cercis canadensis</i>	<i>Dillenia suffruticosa</i>	<i>Ilex aquifolium</i>
<i>Amelanchier laevis</i>	<i>Cercis chinensis</i>	<i>Diospyros kaki</i>	<i>Ilex macrocarpa</i>
<i>Amelanchier lamarckii</i>	<i>Cercis siliquastrum</i>	<i>Diospyros lotus</i>	<i>Indigofera tinctoria</i>
<i>Amelanchier ovalis</i>	<i>Chaenomeles japonica</i>	<i>Dipelta floribunda</i>	<i>Ixora javanica</i>
<i>Amelanchier ovalis</i>	<i>Chaenomeles sinensis</i>	<i>Dracaena reflexa</i>	<i>Jasminum nudiflorum</i>
<i>Amelanchier spicata</i>	<i>Chaenomeles speciosa</i>	<i>Dracaena surculosa</i>	<i>Juglans nigra</i>
<i>Amorpha fruticosa</i>	<i>Chimonanthus praecox</i>	<i>Duranta erecta</i>	<i>Juglans regia</i>
<i>Anagyris foetida</i>	<i>Chionanthus retusus</i>	<i>Edgeworthia tomentosa</i>	<i>Juniperus communis</i>
<i>Andrographis paniculata</i>	<i>Chionanthus virginicus</i>	<i>Ehretia dicksonii</i>	<i>Juniperus phoenicea</i>
<i>Aralia elata</i>	<i>Choisya ternata</i>	<i>Elaeagnus angustifolia</i>	<i>Justicia gendarussa</i>
<i>Araucaria araucana</i>	<i>Cinnamomum camphora</i>	<i>Elaeagnus pungens</i>	<i>Kalopanax septemlobus</i>
<i>Arbutus menziesii</i>	<i>Cinnamomum tenuifolium</i>	<i>Elaeagnus rhamnoides</i>	<i>Kerria japonica</i>
<i>Arbutus unedo</i>	<i>Cistus albidus</i>	<i>Elaeagnus</i> ×	<i>Koelreuteria paniculata</i>
<i>Argyrocystis battandieri</i>	<i>Cistus albidus</i>	<i>submacrophylla</i>	<i>Kolkwitzia amabilis</i>
<i>Aronia arbutifolia</i>	<i>Cistus creticus</i> subsp.	<i>Elaeagnus umbellata</i>	<i>Laburnum alpinum</i>
<i>Aronia prunifolia</i>	<i>eriocephalus</i>	<i>Eleutherococcus</i>	<i>Laburnum anagyroides</i>
<i>Asparagus acutifolius</i>	<i>Cistus ladanifer</i>	<i>sieboldianus</i>	<i>Lagerstroemia indica</i>
<i>Asparagus acutifolius</i>	<i>Cistus laurifolius</i>	<i>Erica arborea</i>	<i>Lagunaria patersonia</i>
<i>Aucuba japonica</i>	<i>Cistus salvifolius</i>	<i>Erica multiflora</i>	<i>Lantana camara</i>

Lavandula angustifolia
Lavandula latifolia
Lavandula stoechas
Lawsonia inermis
Ledum palustre
Ligustrum lucidum
Ligustrum ovalifolium
Liquidambar orientalis
Liquidambar styraciflua
Liriodendron chinense
Liriodendron tulipifera
Lonicera acuminata
Lonicera caprifolium
Lonicera × heckrottii
Lonicera implexa
Lonicera involucrata
Lonicera ligustrina var.
pileata
Lonicera maackii
Lonicera nigra
Lonicera × purpusii
Lonicera tatarica
Lonicera xylosteum
Loropetalum chinense
Lycium barbatum
Machilus nanmu
Maclura pomifera
Magnolia acuminata
Magnolia denudata
Magnolia figo
Magnolia grandiflora
Magnolia kobus
Magnolia liliiflora
Magnolia obovata
Magnolia sieboldii
Magnolia × soulangeana
Magnolia stellata
Magnolia tripetala
Magnolia × wiesneri
Mahonia bealei
Malus domestica
Malus floribunda
Malus × purpurea
Malus sargentii
Malus sylvestris
Malus toringo
Malus toringoides
Malus trilobata
Malvaviscus arboreus
Manihot esculenta
Melastoma malabathricum
Mentha × piperita
Mespilus germanica
Metasequoia
glyptostroboides
Morus alba
Morus nigra
Murraya paniculata
Mussaenda erythrophylla
Mussaenda philippica
Nerium oleander
Nothofagus antarctica
Nyssa sylvatica
Olea europaea
Ononis minutissima
Orthosiphon aristatus
Osmanthus × burkwoodii
Osmanthus fragrans
Ostrya carpinifolia
Ostrya virginiana
Oxydendrum arboreum
Paeonia × suffruticosa
Parrotia persica
Parrotiopsis
jacquemontiana
Parthenocissus inserta
Parthenocissus
quinquefolia
Parthenocissus
tricuspidata
Passiflora caerulea
Paulownia tomentosa
Persicaria minor
Petteria ramentacea
Phellodendron amurense
Philadelphus coronarius
Phillyrea angustifolia
Photinia × fraseri
Photinia davidiana
Phyllanthus myrtifolius
Phyllostachys edulis
Physocarpus opulifolius
Phytolacca dioica
Picea abies
Picea asperata
Picea breweriana
Picea engelmannii
Pieris floribunda
Pinus nigra
Piper sarmentosum
Pistacia lentiscus
Pittosporum tobira
Platanus hispanica
Platanus orientalis
Plumbago auriculata
Podocarpus macrophyllus
Polyscias balfouriana
Populus alba
Populus balsamifera
Populus × canescens
Populus deltoides subsp.
monilifera
Populus nigra
Populus simonii
Populus tremula
Prunus armeniaca
Prunus avium
Prunus cerasifera
Prunus cerasus
Prunus davidiana
Prunus domestica
Prunus dulcis
Prunus fenzliana
Prunus incana
Prunus incisa
Prunus laurocerasus
Prunus lusitanica
Prunus maackii
Prunus mahaleb
Prunus mume
Prunus padus
Prunus persica
Prunus sargentii
Prunus serotina
Prunus serrula
Prunus serrulata
Prunus sibirica
Prunus spinosa
Prunus subhirtella
Prunus triloba
Pseudotsuga menziesii
Ptelea trifoliata
Pterocarya pterocarpa
Pterocarya stenoptera
Pterostyrax corymbosus
Punica granatum
Pyracantha coccinea
Pyrus betulifolia
Pyrus calleryana
Pyrus communis
Pyrus pyraster
Pyrus pyrifolia
Pyrus salicifolia
Quercus acuminata
Quercus alba
Quercus canariensis
Quercus castaneifolia
Quercus cerris
Quercus coccifera
Quercus coccinea
Quercus dentata
Quercus frainetto
Quercus × hispanica
Quercus ilex
Quercus ilicifolia
Quercus imbricaria
Quercus libani
Quercus macranthera
Quercus macrocarpa
Quercus marilandica
Quercus palustris
Quercus petraea
Quercus phellos
Quercus pontica
Quercus pubescens
Quercus pyrenaica
Quercus robur
Quercus rubra
Quercus shumardii
Quercus suber
Quercus velutina
Rauvolfia serpentina
Rhamnus alaternus
Rhamnus cathartica
Rhamnus imeretina
Rhamnus saxatilis
Rhodomyrtus tomentosa
Rhodotypos scandens
Rhus coriaria
Rhus typhina
Ribes alpinum
Ribes aureum
Ribes rubrum
Ribes sanguineum
Ribes uva-crispa
Ricinus communis
Robinia hispida
Robinia luxurians
Robinia pseudoacacia
Robinia viscosa
Rosa canina
Rosa spinosissima
Rosmarinus officinalis
Rubia peregrina
Rubus idaeus
Rubus vestitus
Ruta angustifolia
Salix alba
Salix aurita
Salix babylonica
Salix caprea
Salix cinerea
Salix fragilis
Salix irrorata
Salix purpurea
Salix viminalis
Sambucus nigra
Sambucus racemosa
Sassafras albidum
Sauropus androgynus
Schinus molle
Sciadopitys verticillata
Sedum anopetalum
Sedum sediforme
Sequoia sempervirens
Shepherdia argentea
Skimmia japonica
Smilax aspera
Sorbaria sorbifolia
Sorbus alnifolia
Sorbus aria
Sorbus aucuparia
Sorbus domestica
Sorbus intermedia
Sorbus torminalis
Spartium junceum
Spiraea × billardii
Spiraea × vanhouttei
Spiraea japonica
Spiraea salicifolia
Spiraea thunbergii
Stachyurus praecox
Staelhelia dubia
Staphylea pinnata
Stewartia pseudocamellia
Strobilanthes crispa
Styphnolobium japonicum
Styrax japonicus
Symphoricarpos albus
Symphoricarpos
orbiculatus
Syringa josikaea
Syringa komarowii
Syringa vulgaris
Tabernaemontana
divaricata
Taxodium distichum
Taxus baccata
Tetracera scandens
Tetradium daniellii
Thuja occidentalis
Thuja plicata
Thujopsis dolabrata
Thymus vulgaris
Tibouchina urvilleana
Tilia americana
Tilia cordata
Tilia dasystyla
Tilia × euchlora
Tilia × europaea
Tilia mongolica
Tilia platyphyllos
Tilia tomentosa
Tipuana tipu
Toona sinensis
Tsuga canadensis
Tsuga heterophylla
Ulmus glabra
Ulmus laevis
Ulmus minor
Ulmus parvifolia
Ulmus pumila
Vaccinium myrtillus
Vaccinium vitis-idaea
Viburnum × bodnantense
Viburnum × burkwoodii
Viburnum davidii
Viburnum farreri
Viburnum lantana
Viburnum lantanoides
Viburnum lentago
Viburnum odoratissimum
var. awabuki
Viburnum opulus
Viburnum rhytidophyllum
Viburnum tinus
Vinca minor
Viscum album
Vitex agnus-castus
Vitis coignetiae
Vitis vinifera
Weigela florida
Wisteria sinensis

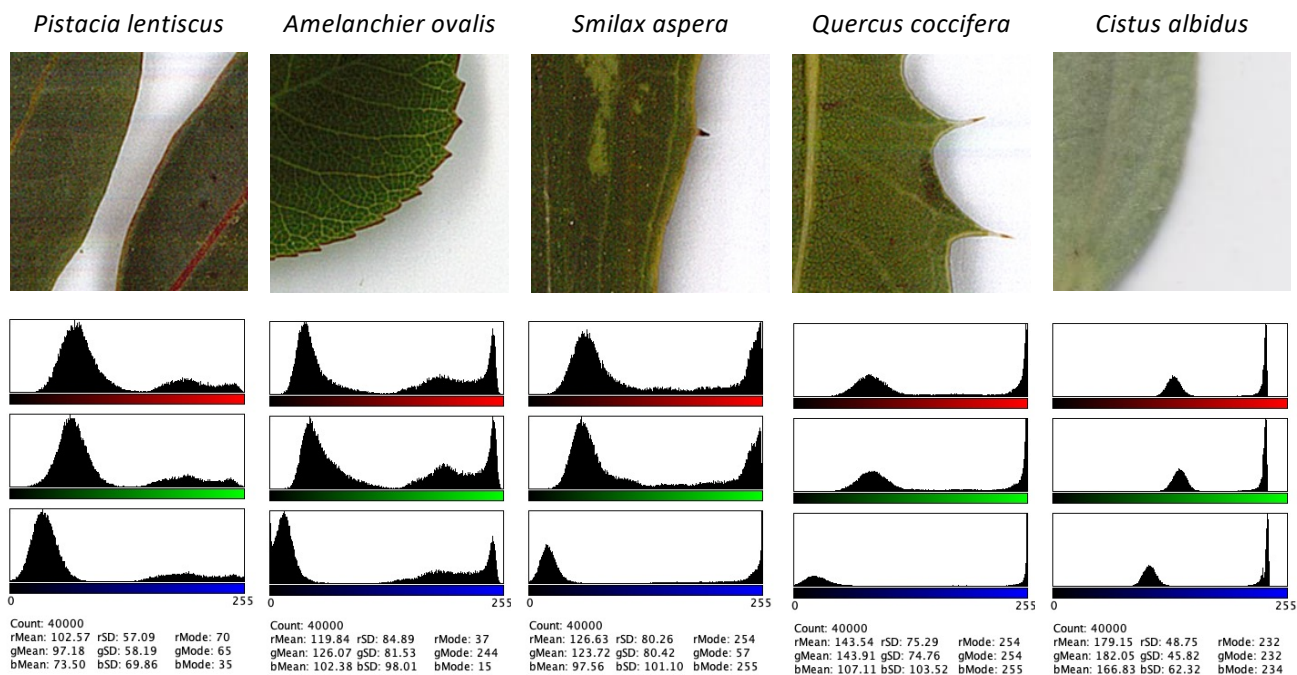
Appendix 2: Comparative analysis of leaf area measurement methods considering the number of species and leaves used for the validation process, the automation level of the method (level 1: image processing requires user adjustments, level 2: image processing is automated but only for one file, level 3: image processing is automated on multiple files with a batch process), the measured features (A, P, L, W, C, S referred respectively to Area, Perimeter, Length, Width, Circularity and Solidity) and whether or not the software was free. Availability/Reproducibility was set to “No” when methodology was incompletely described, complete algorithm not given or software no longer available.

Authors	Nb of species	Total nb of leaves	Automation level	Automated analysis tool	Features measured	Free / Not free	Availability Reproducibility
Current study	587	2218	level 3	FAMeLeS (ImageJ Macro)	A, P, L, W, C, S	Free	Yes
Igathinathane et al. (2006)	4	12	level 1	Leaf area software	A, P, L, W	Free	No
Bylesjö et al. (2008)	1	50	level 1	Lamina (software)	A, P, L, W, C	Free	No
Li et al. (2008)	6	60	level 2	Matlab algorithm (software)	A	Not free	No
Rico-Garcia et al. (2009)	2	20	level 1	Matlab algorithm (software)	A	Not free	Yes
Fermat-Diaz et al. (2011)	17	47	level 3	Scanner image methodology (SIM)	A, L, W	Free	No
Patil & Bodhe ((2011)	1	4	level 1	Matlab algorithm (software)	A	Not free	Yes
Can et al. (2012)	1	15	level 2	OLAT (PHP scripting)	A	Free	No
Chaudhary et al. (2012)	unknown	70	level 2	Matlab algorithm (software)	A	Not free	No
Jingwen & Hong (2012)	unknown	10	level 2	Visual studio algorithm (Snake model)	A, P	Not free	No
Gong et al. (2013)	3	15	level 1	Software (run on HHD prototype)	A	Not free	No
Varma & Osuri (2013)	51	100	level 3	Black Spot (software)	A	Free	Yes
Easlson & Bloom (2014)	1	50	level 1	Easy Leaf Area (Android software)	A	Free	Yes
Kaiyan (2014)	1	10	level 3	Algorithm (C # language)	A	Free	No
Karatassiou et al. (2015)	5	240	level 1	Lafore (software)	A	Free	No
Katabuchi (2015)	unknown	100	level 3	LeafArea (R package)	A	Free	Yes
Jadon et al. (2016)	3	45	level 2	Matlab algorithm (software)	A	Not free	No
Haqqiman et al. (2016)	3	16	level 1	LAMOS (Visual C++)	A	Free	No
Amiri & Shabani (2017)	61	61	level 1	ANFIS model (Matlab)	A, L, W	Not free	No
Drienovsky et al. (2017)	3	30	level 2	Scan LeafArea (software)	A	Free	No
Schrader et al. (2017)	18	25	level 2	Leaf-IT (Android app.)	A	Free	Yes
Datta and Chakroboarty (2018)	10	10	level 1	Algorithm (Adobe Photoshop CS)	A	Not free	No
Tech et al. (2018)	1	20	level 2	USPLeaf (software)	A	Free	No
Liu et al. (2019)	4	40	level 2	Android app.	A, P, L, W	Free	No
Siswanto & Made Artadana (2019)	3	30	level 1	Artificial Neural Network	A, P, L, W		No
Meira et al. (2020)	2	30	level 3	USPLeaf (software)	A	Free	No
Getman-Pickering et al. (2020)	14	67	level 2	LeafByte (iOS app.)	A	Free	Yes
Nguyen et al. (2021)	28	28	level 1	Android app.	A, P, L, W	Free	No

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Appendix 3 : Examples of spectral reflectance of leaf, shadow and background in red, green and blue channels of RGB images. On the left, there's a peak corresponding to pixels with low reflectance values, representing leaves. On the right, there's another peak with pixels having high reflectance values, indicating the white background (and potentially bright areas of the leaves). In the intermediate zone, there's a mix of pixels from shadows and certain parts of the leaves



Appendix 4: Step by step procedure to use the macro Fameles

Step 1: install the freeware Fiji[®] (or ImageJ[®]): <https://imagej.net/software/fiji/downloads>

Step 2: install the “ResultsToExcel” plugin (<https://imagej.net/User:ResultsToExcel>) or go to Fiji menu: Help->Update->”Manage Update sites” and select *ResultsToExcel*). This step is optional if you don’t want to save your data in an excel file format.

Step 3: Create on the computer the following four folders to store input pictures (an image file can contain one or multiple leaves) and to save the output files generated by the macro (one leaf, one output file):

- 01_ Input_files: copy the RGB files to process into this folder
- 02_ Thumbnails: in this folder, each leaf will be saved as an individual file, even if there are multiple leaves in the original image.
- 03_ Leaf_area: here will be saved the files of the final output of the thresholding: black leaves on a white background
- 04_ Leaf_perimeter: here will be saved the files of the outline of the leaves (each numbered from the top to the bottom of the image, with a continuous numbered across files)

Step 4: Download the latest version of the macro:
(<https://doi.org/10.6084/m9.figshare.22354405>)

Step 5: open Fiji[®] (or ImageJ[®]) and install the macro (Menu *Plugins->Macro->Install*). An alternate method is edit the macro from Fiji (*Plugins -> Macro -> Edit*) and run. Depending on the version of Fiji, an update (menu *Help -> Update ImageJ -> Daily build*) will be needed to have *Composite ROIs* option in *Analyze Particles* plugin.

Step 6: When the macro starts, select sequentially (i.e., in the right order) each of the three folders when prompted. The macro will run and automatically fill the folders with the corresponding files. An Excel file will be automatically generated on the desktop at the end of the process, with the default filename “Rename me after writing is done”. Data are stored in pixel units. The Count, Label, Area, Perim., Circ., Length, Width and Solidity column headings corresponds respectively to the number attributed to the leaf (a unique number for each leaf, starting from the upper leaf of the first file and ending with the lower leaf of the last file), the file name, leaf area, perimeter, circularity, length, width and solidity.

The circularity index determines how the leaf shape is similar to a circle (Yahiaoui et al. 2012). This index varies between 0 (elongated shapes) and 1 (a circle).

$$C = \frac{4\pi \times \text{Area}}{\text{Perimeter}^2}$$

The solidity index proposed by Wu et al. (2006) is the ratio between the leaf area and the convex hull of the leaf shape. It measures how well the leaf area fits a convex shape and can be considered as a proxy of margin undulation.

$$S = \frac{\text{Area}}{\text{Convex Hull}}$$

The scale can be calculated later or implemented in the script if needed (*Analyze -> Set Scale*). However, we highly recommend storing data in pixels to have a backup of raw data since scale can differ depending on the way it was calculated (from scanner resolution or with a known scanned surface area).

For those who want to check each stage of the processing or may need to troubleshoot, it's possible to optionally save the intermediate files created during the image processing. This can be done without requiring additional skills. In that case, two additional folders must be created to store the intermediate files:

- 01a_Bandpass_files: the files saved in this folder are obtained from the RGB input files after a bandpass filter was applied that creates a halo effect around the leaves to remove light shadows
- 01b_Contrasted_files: here will be saved the files combining the mask and the bandpass files to produce a contrasted picture

To allow intermediate savings, edit the script (Menu *Plugins->Macro->Edit*) and remove the symbols *///* in front of the corresponding lines before launching the process.

Reference in Appendix 4:

- Yahiaoui, I., Mzoughi, O., & Boujemaa, N. (2012). Leaf Shape Descriptor for Tree Species Identification. *2012 IEEE International Conference on Multimedia and Expo*, 254–259. <https://doi.org/10.1109/ICME.2012.130>
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Appendix 5:

Spearman correlations between foliar traits values and measurement errors (mean percentage of error between estimated and manually measured values). The larger the circle, the stronger the correlation. n = 2218.

