ARACNE:

"ADVOCATING THE ROLE OF SILK ART AND CULTURAL HERITAGE AT NATIONAL AND EUROPEAN SCALE"

Deliverable 1.3

Specification guide and manual to correctly use the *Morus* sp. Census application

Version 1.0

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Authors: Andreja Urbanek Krajnc, Martin Kozmos, Johannes Rabensteiner, Gianni Fila, Silvia Cappellozza
Project editor: Silvia Cappellozza
Application design: Nejc Pezdevšek, Nejc Hauptman, Luka Hrgarek
Reviewer: Panomir Tzenov, Gianni Fila
Photographic material: Andreja Urbanek Krajnc, Johannes Rabensteiner, Gianni Fila, Anja Ivanuš, Mateja Šelih
Illustrators: Martin Kozmos, Anton Ivančič
Illustration, photo design and editing: Martin Kozmos

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Dissemination Level

☒	**PU:**	Public
☐	**SEN:**	Sensitive
☐	**PP:**	Restricted to other programme participants (including the Commission Services)
☐	**RE:**	Restricted to a group specified by the consortium (including the Commission Services)
☐	**CO:**	Confidential, only for members of the consortium (including the Commission Services)

Abstract

ARACNE aims to build a knowledge bank for the Silk Innovation Ecosystems in Cevennes, Murcia, Padua, Soufli, Tbilisi, Vratsa, and in the context of the European Neighbourhood Policy for a better understanding of European silk-related arts, culture, genetics, landscape, production, industrial and built heritage and values. For this reason, the project aims to identify the old mulberry tree varieties scattered in various germplasm collections in different European countries, considering all the taxonomical and phytogeographical information, their morphological characteristics and all the possible diseases and pests.

An application is necessary for this purpose as it will allow the collection of significant amounts of data and the possibility of being able to use and disseminate them among schools and communities.

This guide provides all the necessary information to use the *Morus*APP which was created to identify old mulberry (Morus sp.) varieties in the different European countries by entering visual observations of individual mulberry trees.

Table of contents

1. Introduction

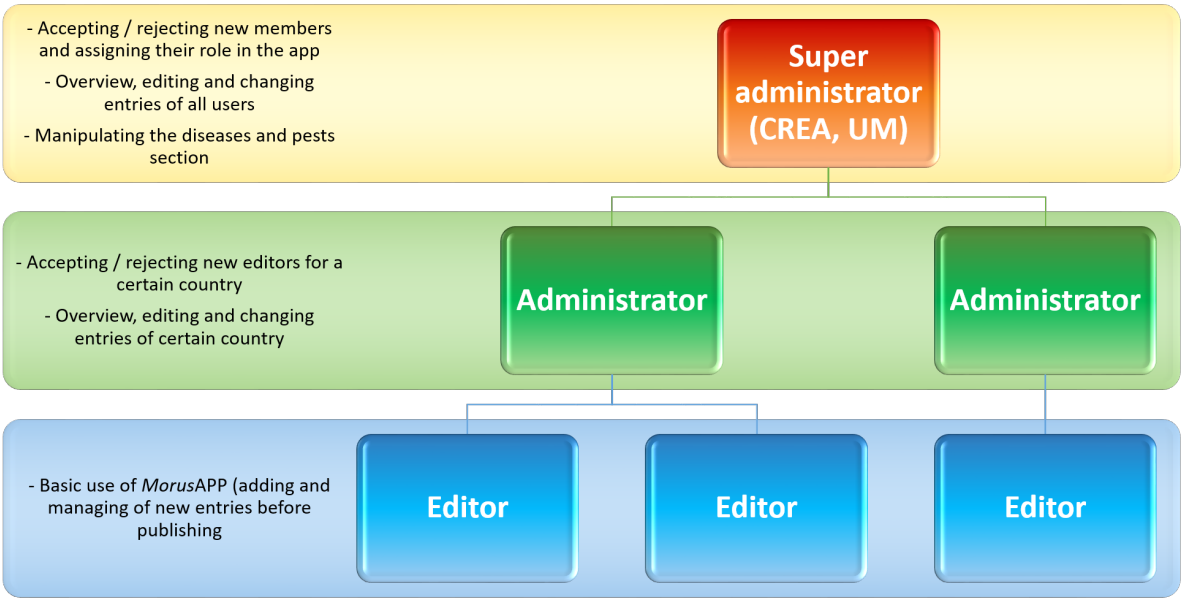
The application – MorusAPP was created with the aim of identifying old mulberry (Morus sp.) varieties in the different European countries by entering visual observations of individual mulberry trees; these could be used to characterise them in sufficient detail, allowing project partners to determine morphotypes of the same species and providing data required to perform advanced statistical analyses. In the application, taxonomic and phytogeographical information, accessibility and number of trees, tree growth habit, tree vigour, pruning practises, trunk shape, morphological characteristics of shoots, leaves and reproductive structures, and observations on diseases and pests will be possibly recorded according to mulberry descriptors, which are basically adapted after 1-3.

The application is conceived to enable the editor to use it in a simple, transparent and at the same time comprehensive way. Through this application, we aim to raise awareness of the importance of the mulberry tree, both in society and in nature, and to preserve genotypes with a long and rich history.

The application allows the user to enter and list specimens of mulberry trees found in the field throughout Europe. Supporting schematic and pictorial information helps the user in choosing which specific parameters to enter. Descriptors, which are designed to create a comprehensive representation of an individual specimen, are provided with images / schemes and remarks for each option. The user can also make decisions with the aid of pre-built schemes with supporting images. In this way, the application can be used by anyone who is interested in this type of subject and wants to contribute to the conservation and enrichment of the existing mulberry genetic pool.

Every entry has the option to be saved while still editable. All these entries can be published after sampling and editing by the editor has been completed. After publication, only administrators and super administrators can edit the entries. The application uses GPS on mobile applications to determine the locations of trees and enter them on the map.

2. Roles in the system



User's roles and levels of access in the system:

i. Editor:

1. In general, the basic ability to use the application
2. The chance of entering and managing his/her own entries
3. The possibility of viewing the entries of other editors of the same partner country, without the possibility of changing those entries
4. Editing and changing the user's data while they are stored in the database

ii. Administrator:

1. Acceptance / rejection of newly registered users at the level of the individual partner countries
2. Entering and managing the user's entries and the entries of all editors of the same country
3. Possibility of editing and changing all entries of the same country after they have been saved in the database
4. Chance of observing all entries of all involved countries, in their entirety, through a pie chart

iii. Super-administrator:

1. Acceptance / rejection of newly registered users (for all included countries)
2. Assigning administrative functions to leading users of individual countries

3. Entering and managing the users' entries, entries of all editors of the users' country and entries of all administrators and editors of other countries
4. Changing all recorded entries after saving them into the database
5. Possibility of adding or removing current mulberry pests and diseases
6. Option to promote an editor to the administrator's role and vice versa for any country
7. The possibility to review and edit all the users of the application

3. Mandatory and optional entries for *Morus*APP

1 Mandatory data to be entered in the application:

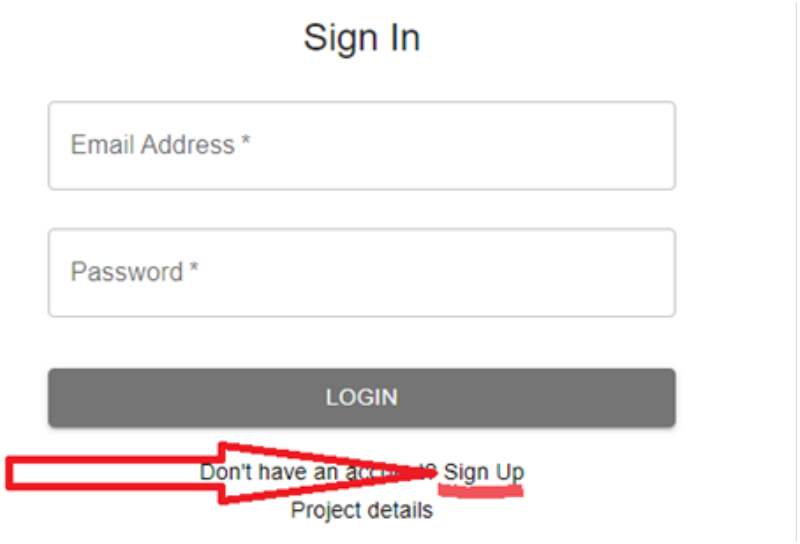
- 1.1 Species
- 1.2 Identification number
- 1.3 Accessibility
- 1.4 Geographical origin
- 1.5 Number of individuals at the location
- 1.6 Tree growth habit
- 1.7 Pruning management
- 1.8 Tree vigour

2 Other not mandatory descriptors:

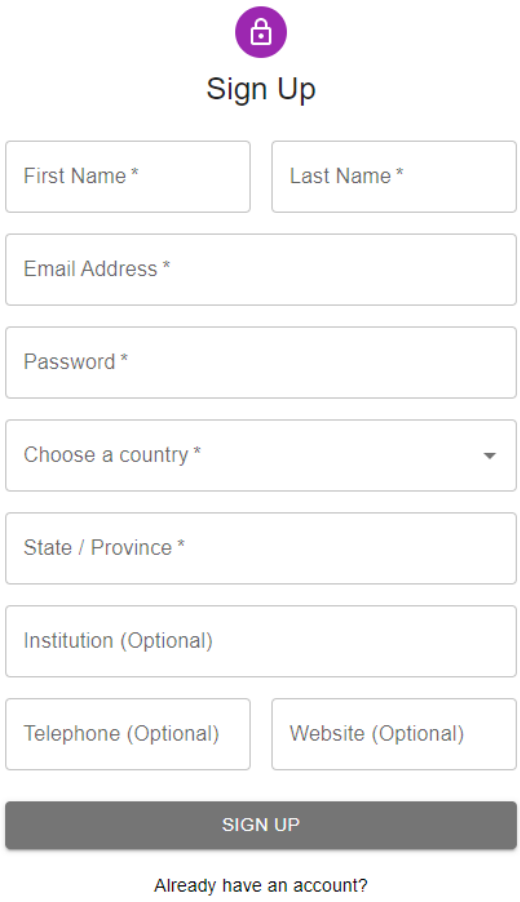
- 2.1 Varietal name
- 2.2 Trunk circumference
- 2.3 Tree growth habit
- 2.4 Trunk
  - 2.4.1 Trunk colour
  - 2.4.2 Trunk irregularities / damage
- 2.5 Shoots
  - 2.5.1 Colour of one-year-old shoot
  - 2.5.2 Lenticel density
  - 2.5.3 Lenticel shape
  - 2.5.4 Buds
    - 2.5.4.1 Shape
    - 2.5.4.2 Colour
- 2.6 Leaves
  - 2.6.1 Phyllotaxis
  - 2.6.2 Leaf shape (lobation / heterophylly)
  - 2.6.3 Leaf blade (ratio; lenght:width)

4. Login page

4.1 Register

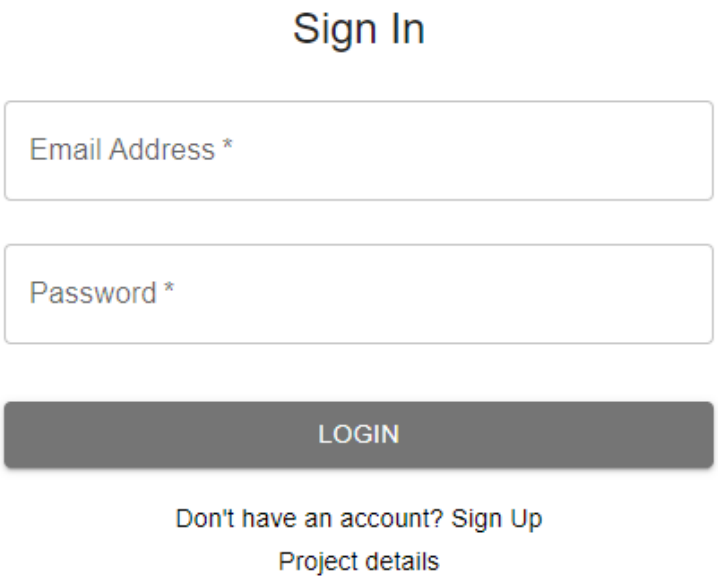


- Click on the **Sign Up** button in the lower right end.



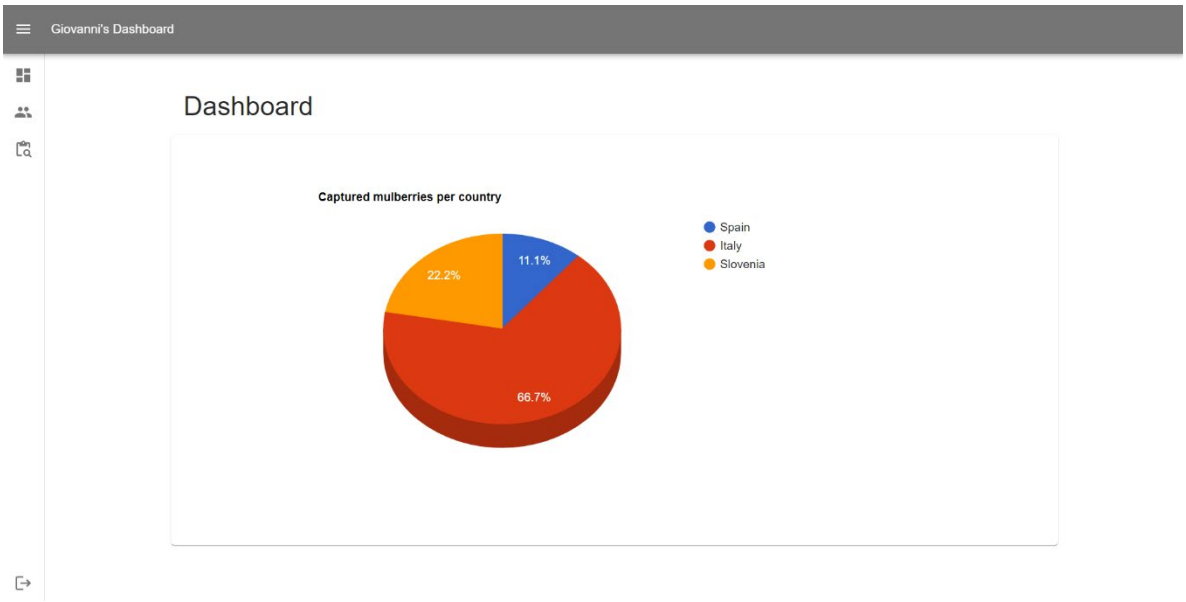
- Fill in your personal information to register new account. Fields marked with * are compulsory for successful registration. The newly registered member then needs to be confirmed and accepted by the Administrator or Super-administrator.

4.2 Sign in



- Sign In with registered details (E-mail Address and Password) to get started.

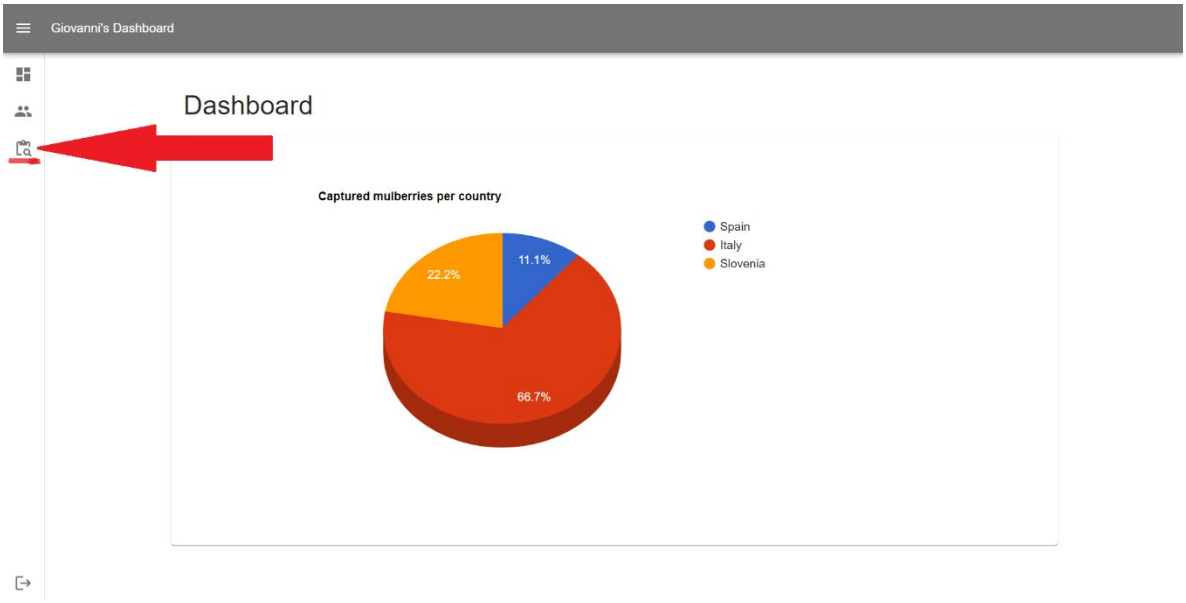
4.3 First page



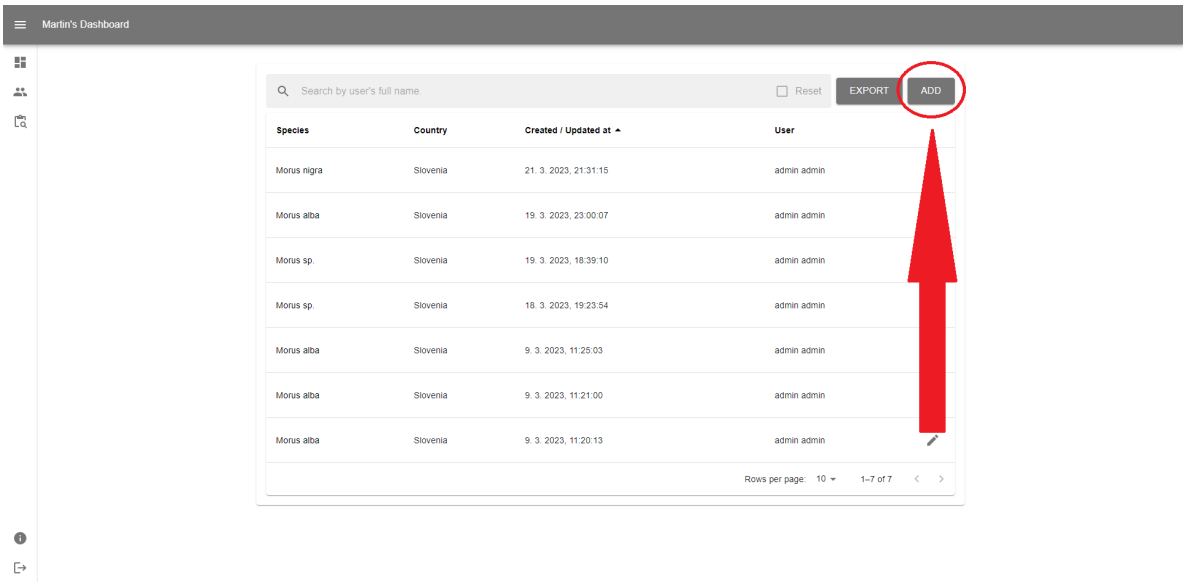
- The first page contains graphical overview of the specimens entered so far by country.

4.4 Getting started

- To start with a new entry, you must first click on the third icon on the left.

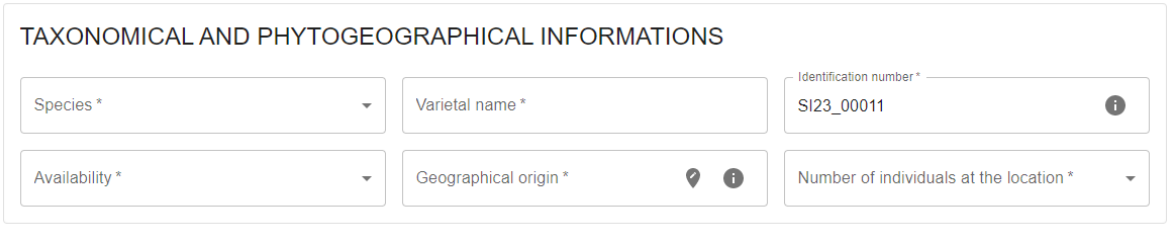


- Then click on the button ADD to start the new entry



Defined categories and entries:

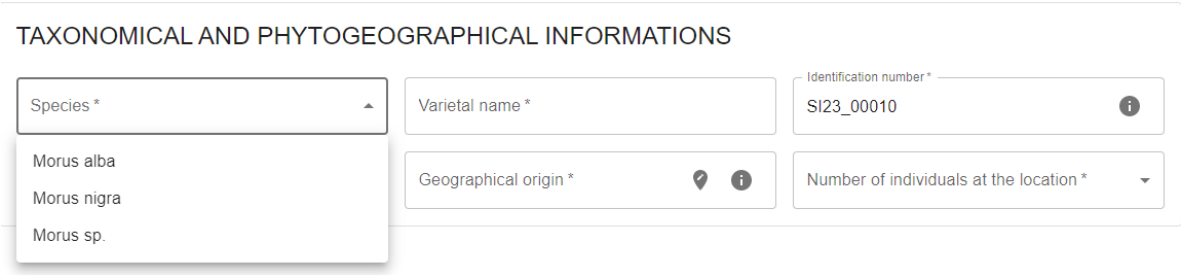
5. Taxonomical and phytogeographical information



5.1 Species (mandatory)

- *Morus alba*
- *Morus nigra*
- *Morus* sp.

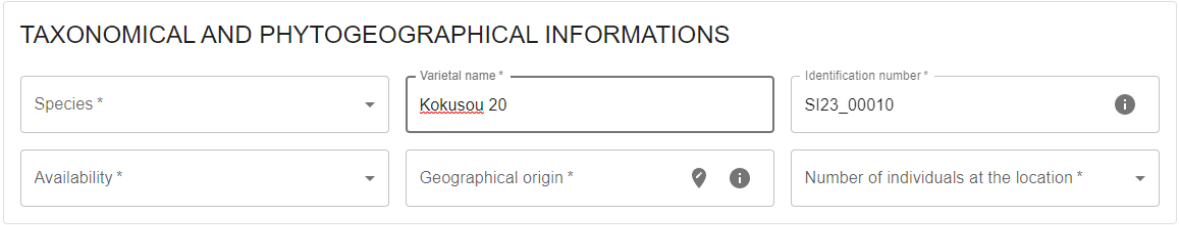
- The entries are statistically presented in form of a pie chart (SI, CREA sees the entries of all countries, the others each see the number of trees of their own country).



5.2 Varietal name (not mandatory)

- Kokusou 20, or 21 or 27 or 70

* Example of input field; manual entry

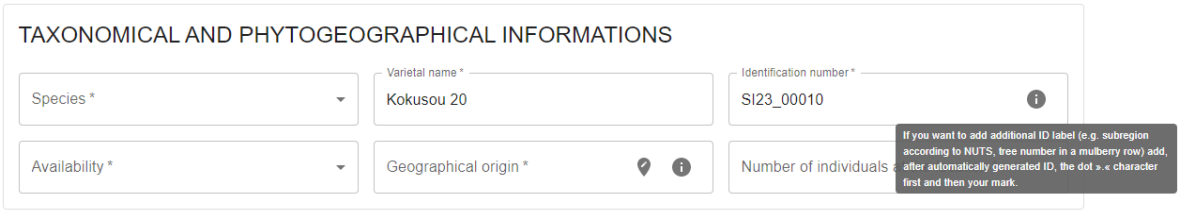


5.3 Identification number (mandatory)

- Example of input field: **SI23_011.1 ***

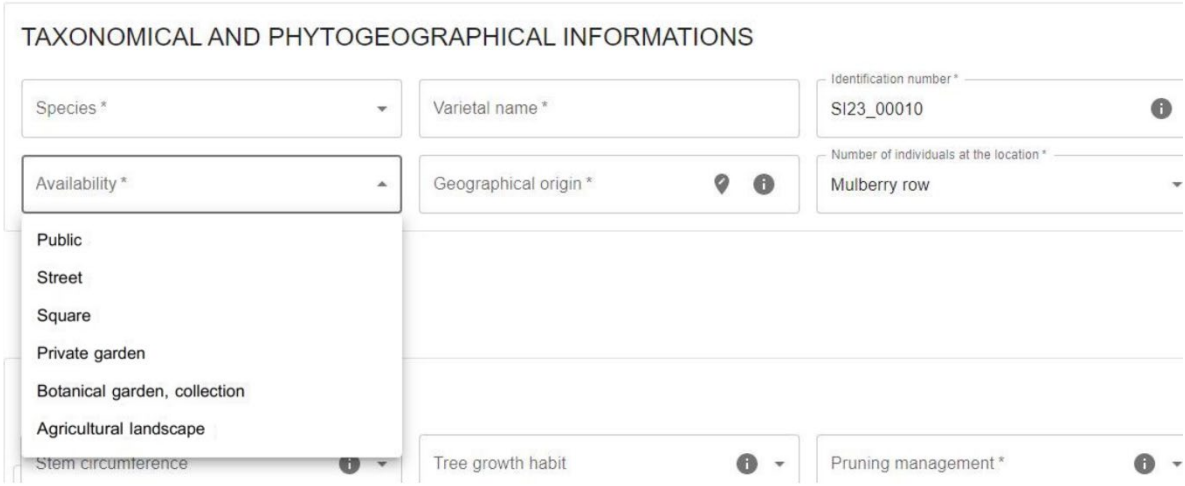
* – **SI** represents abbreviation of the country; e.g. SI – Slovenia
– **23** represents the year of sampling; e.g. 23 – Sample of this entry was take in 2023
– **011.1** represents the serial number of the entry; e.g. 011.1 – This entry is 11th in a row and the decimal points indicates that it is a multiple tree site. The number after decimal point indicates the successive number of the sampled tree.

The identification number is automatically generated and bound to the database, thus avoiding duplicate entries or numerical errors. After the automatically generated part of the ID number, there is also a field for manual input to add your own markings (e.g., sub-categorisation by region would be advisable, example NUTS codes).



5.4 Accessibility (mandatory)

- Public
- Street
- Square/circle
- Private garden
- Botanical garden, collection
- Agricultural landscape

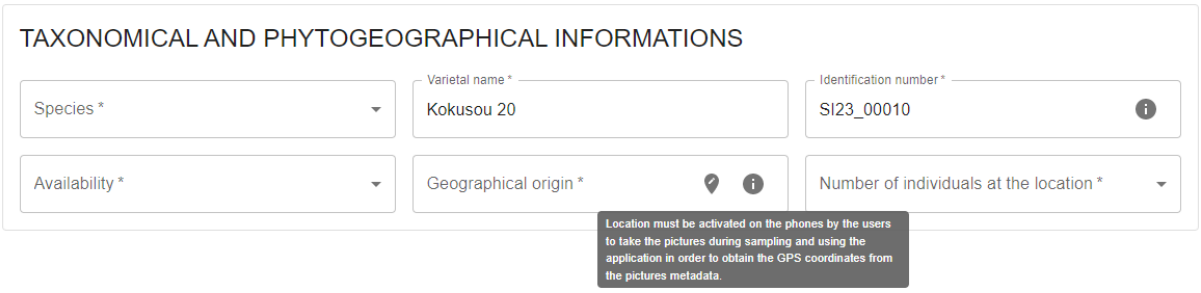


5.5 Geographical origin* (mandatory)

- 46.5084374, 15.6210907

- The program enters the WGS-84 coordinates (decimal numbers) automatically based on the location
- The user can subsequently change/enter the coordinates in case of incorrect/missing entry
- This function can be used everywhere, without internet connection

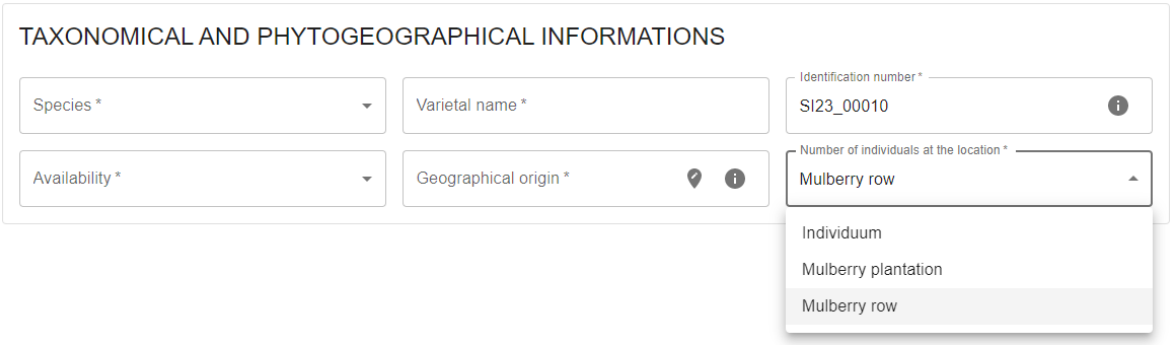
* "**Location**" must be activated on the phones by the users to take the pictures during sampling and using the application in order to obtain the GPS coordinates from the pictures metadata.



5.6 Number of individuals at the location (mandatory)

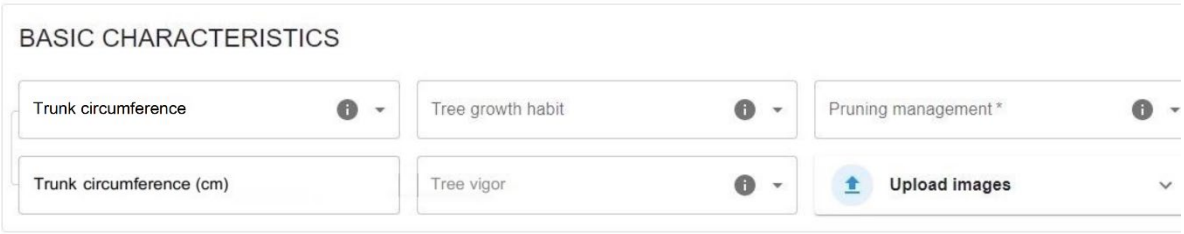
- Individuum

- Mulberry plantation
- Mulberry row



6. Morphological characteristics

6.1 Basic characteristics



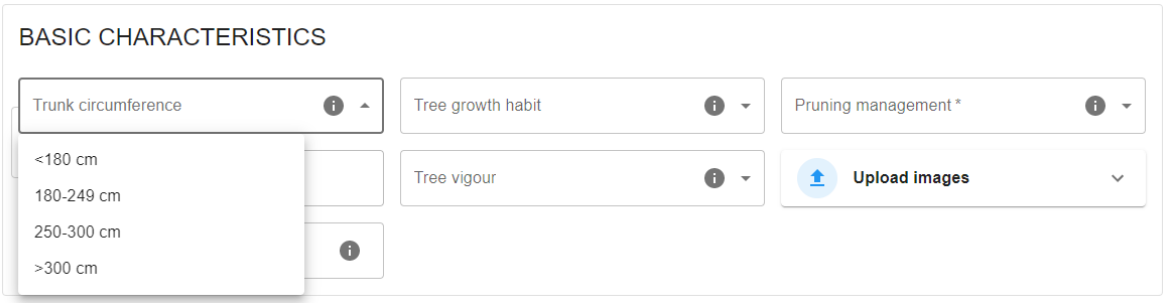
6.1.1 Trunk circumference (CBH, cm)* (not mandatory)

- < 180 cm
- 180-249 cm
- 250-300 cm
- >300 cm
- _____ (Fill in; numeric, non-decimal)

* Circumference of the specimen is taken at breast height;

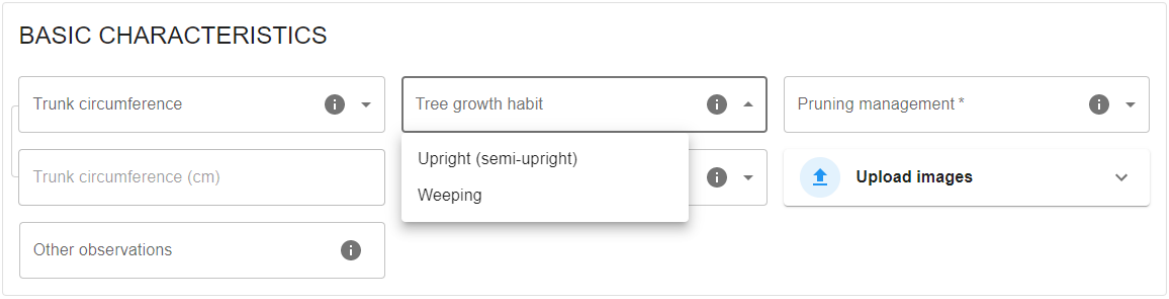
If the tree is of low form or irregularly shaped, the height should be individually measured at the representative diameter.

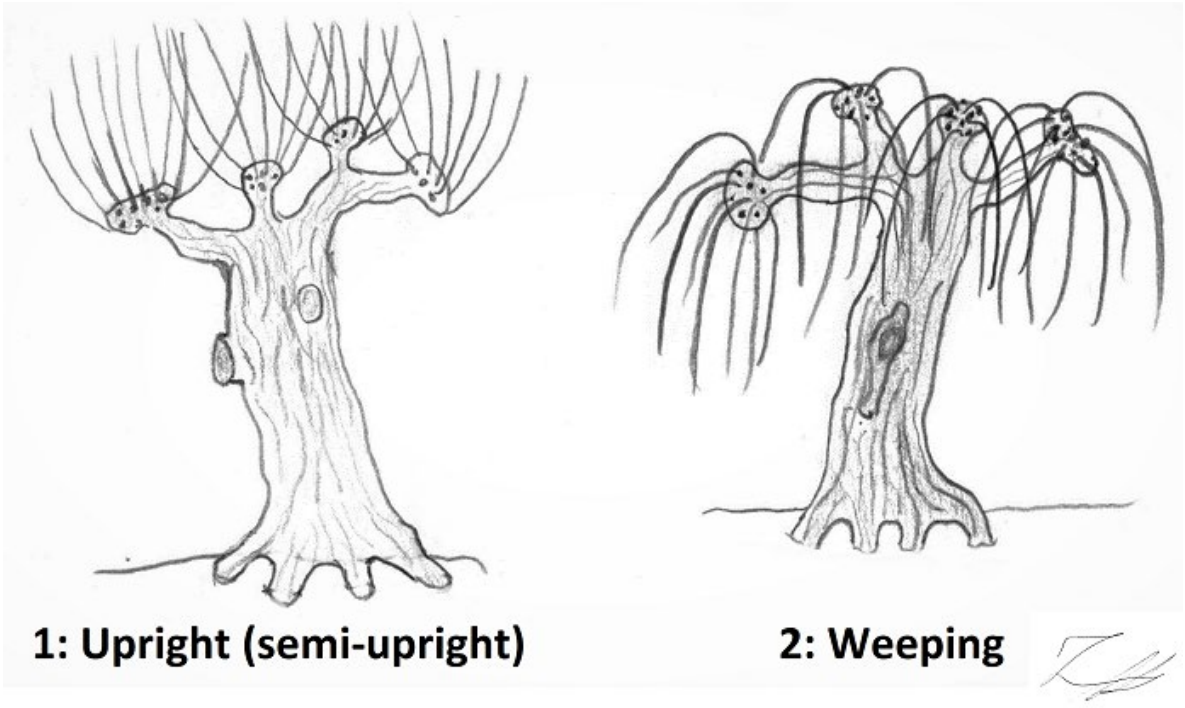
Final number of recorded mulberry trees is visualized in form of a pie chart (SI and CREA can see entries of all partners, other partners can only see the number of trees of their own country).



6.1.2 Tree growth habit* (not mandatory)

- Upright (semi-upright)
- Weeping

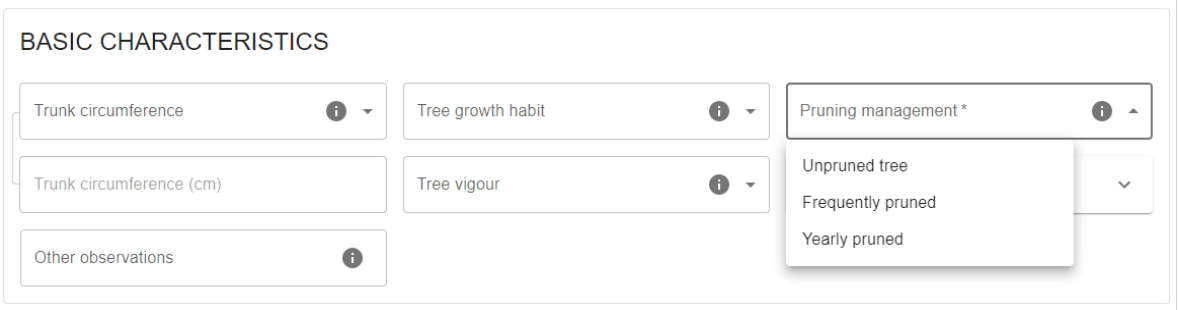




* The user should upload a photo of tree habitus (1 photo).

6.1.3 Pruning management (mandatory)

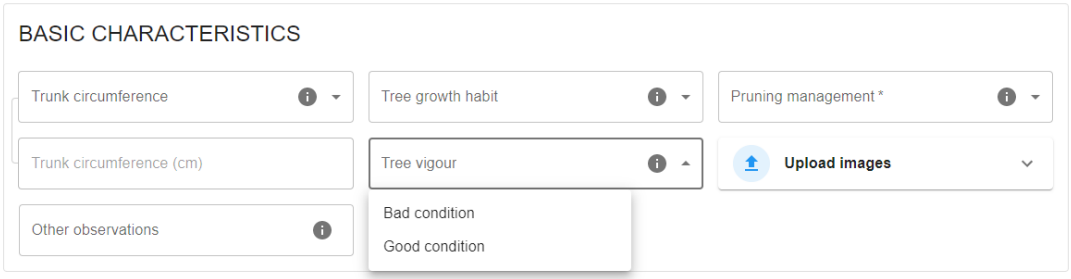
- Unpruned tree
- Frequently pruned
- Yearly pruned tree



1: Unpruned tree **2: Frequently pruned** **3: Yearly pruned**

6.1.4 Tree vigour (mandatory)

- Bad condition
- Good condition



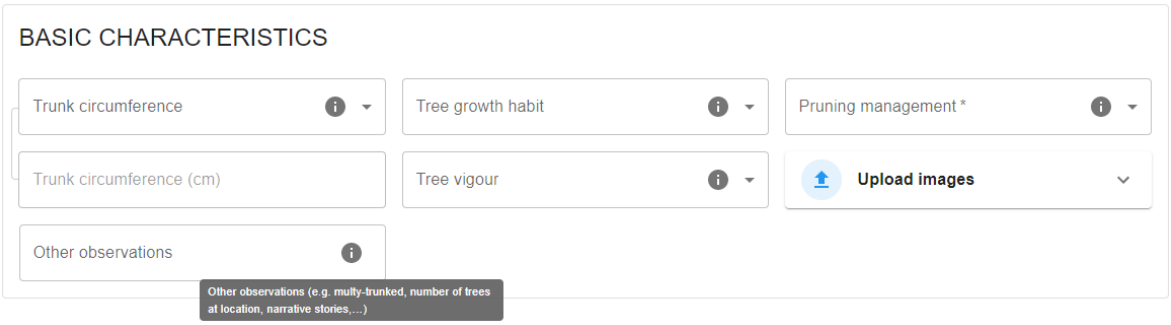
1: Bad condition **2: Good condition**

6.1.5 Other observations

(e.g. multi-trunked tree, number of trees at location, narrative stories,…)(not mandatory):

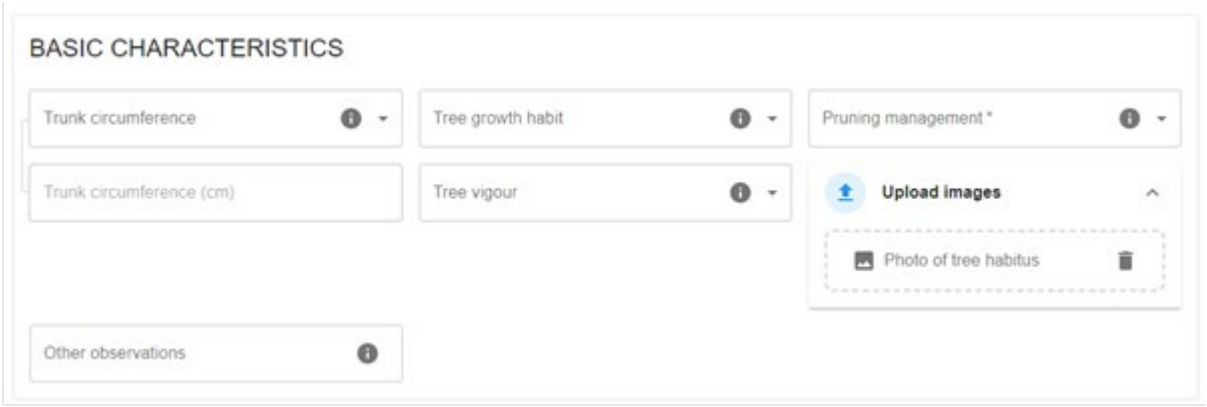
The user should enter further specific observations about the tree and the site in text form.

- [ ]

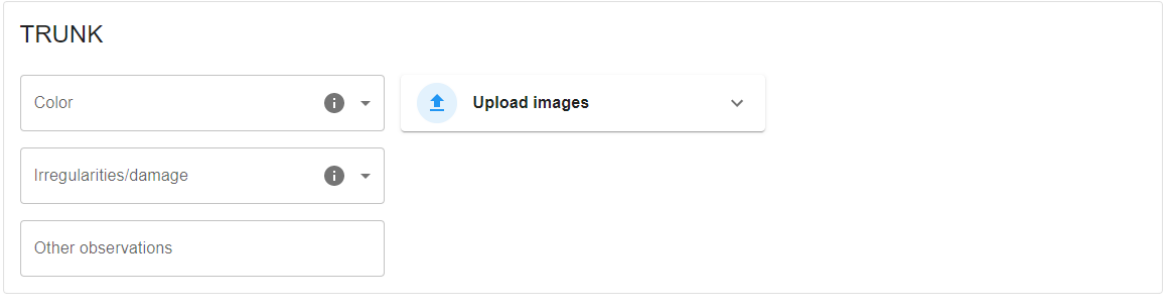


6.1.6 Upload images

The user should upload one image of the tree habitus showing trunk circumference, tree growth habit, pruning management and tree vigour (1 photo).

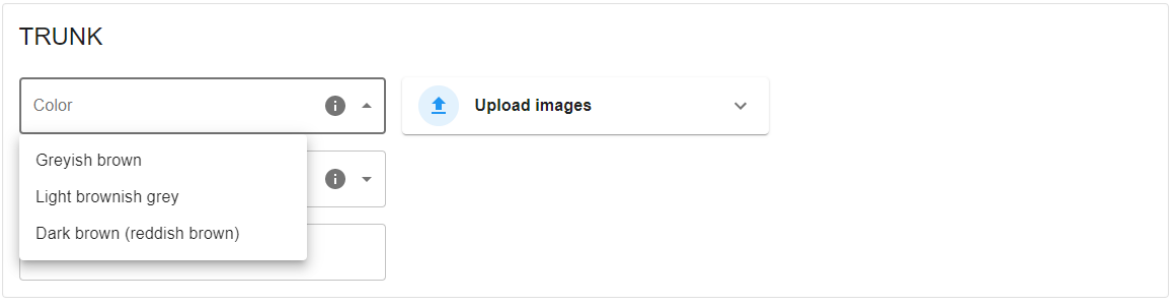


6.2 Trunk



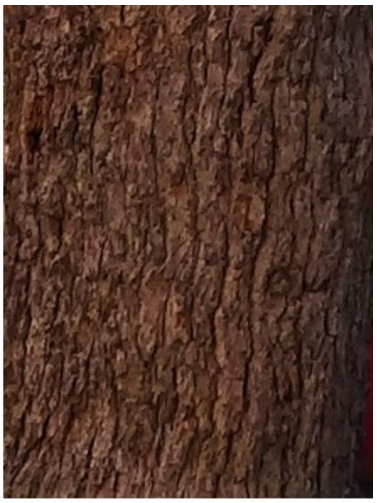
6.2.1 Trunk colour* (not mandatory)

- Greyish brown
- Light brownish grey
- Dark brown (reddish brown)



1: Greyish brown

2: Light brownish grey

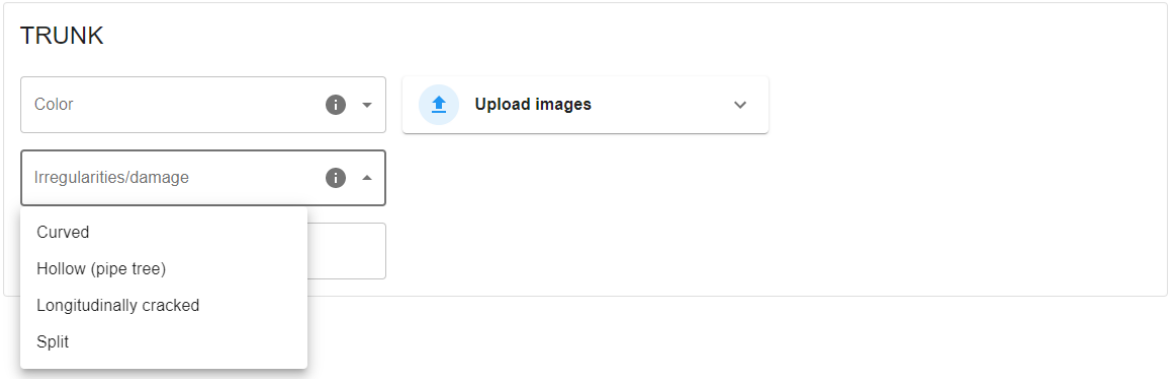


3: Dark brown (reddish brown)

* Further explanations regarding colour can be found at UPOV HERE

6.2.2 Trunk irregularities/damage (not mandatory)

- Curved
- Hollow (pipe tree)
- Longitudinally cracked
- Split




1: Curved

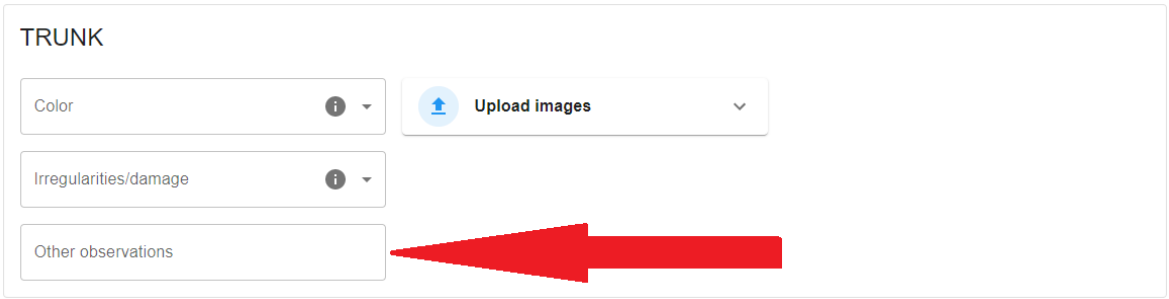

2: Hollow


3: Longitudally cracked


4: Split

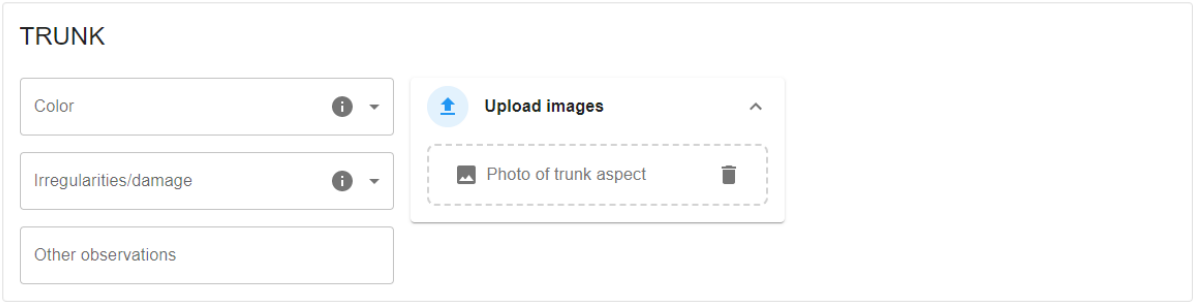
6.2.3 Other observations

The user should enter additional details about tree trunk.



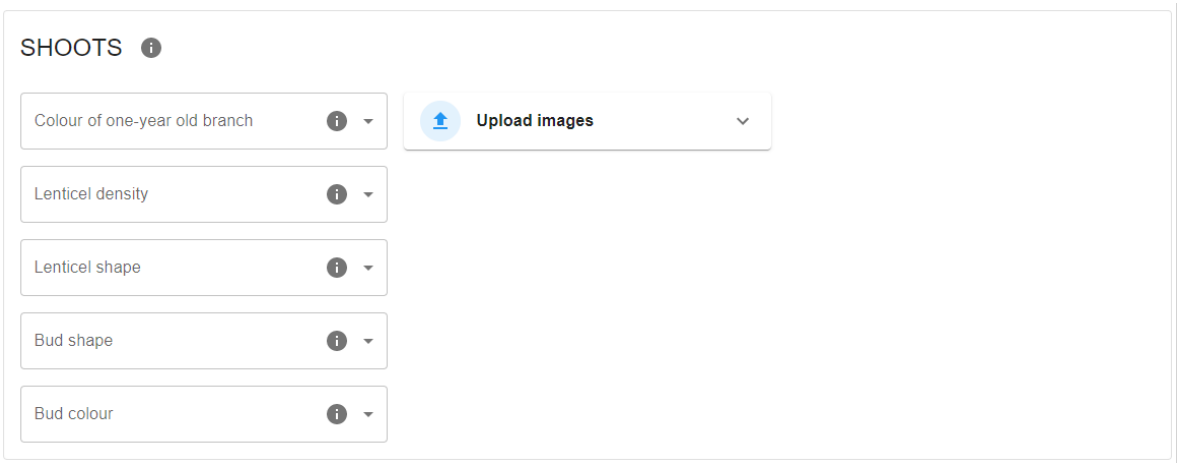
6.2.4 Upload images

The user should upload a photo of a trunk, best representing trunk characteristics (1 photo).



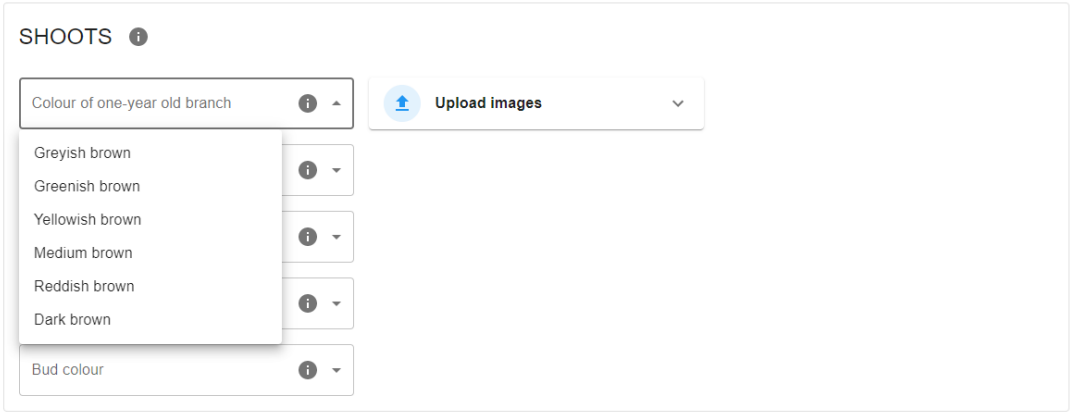
6.3 Shoots

Observations on shoots and buds should be made during winter dormancy. Lenticels can be identified as raised circular, oval, or elongated areas in the bark/rhytidome and are important for peridermal transpiration. Lenticels and bark colour should be observed on the first third of the current year's shoots, on internodes with already evenly developed rhytidome, usually on yearly pruned trees between the 5th and 7th internode of the shoot base.



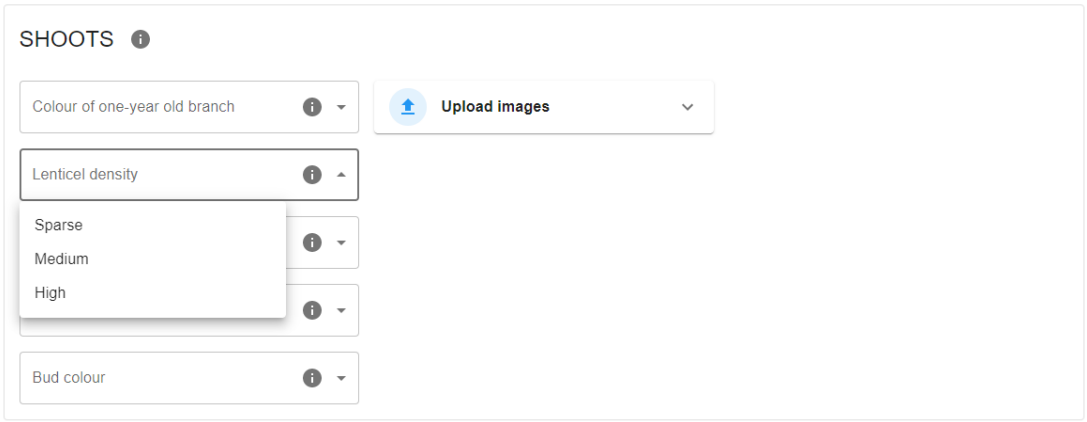
6.3.1 Colour of one-year old branch (not mandatory)

- Greyish brown
- Greenish brown
- Yellowish brown
- Medium brown
- Reddish brown
- Dark brown



6.3.2 Lenticel density (not mandatory)

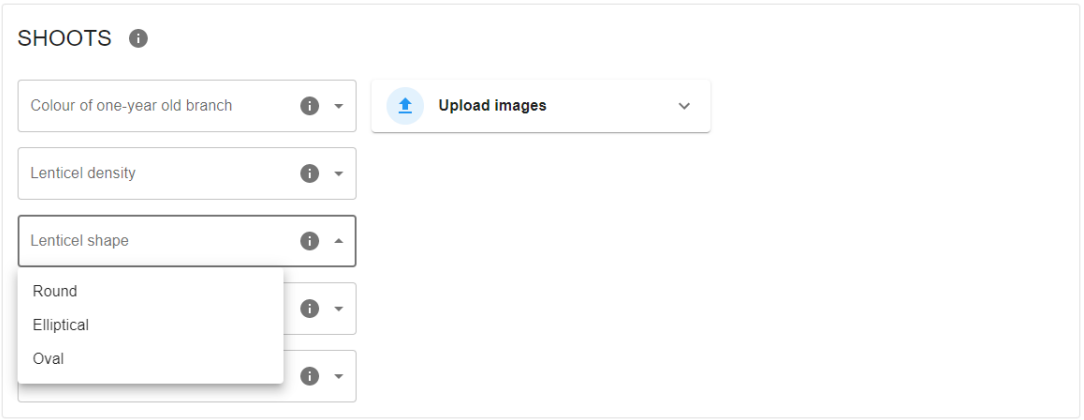
- Sparse
- Medium
- High

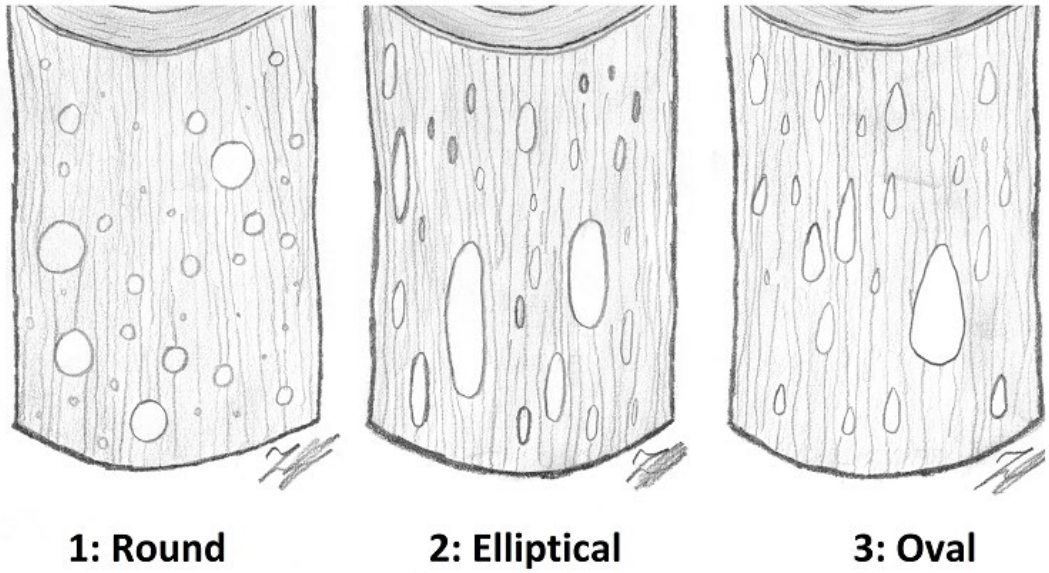


6.3.3 Lenticel shape* (not mandatory)

- Round
- Elliptical
- Oval

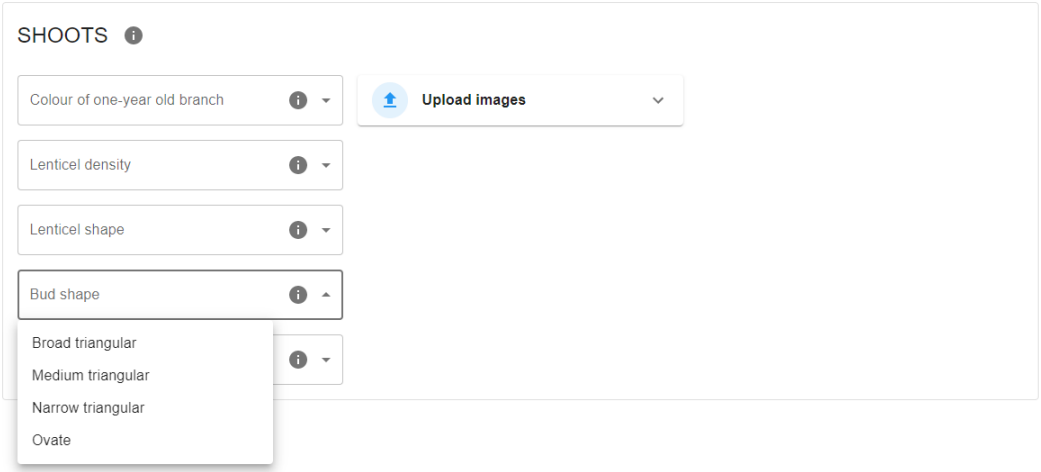
* The user should focus on fully developed lenticels of the current-year shoot.

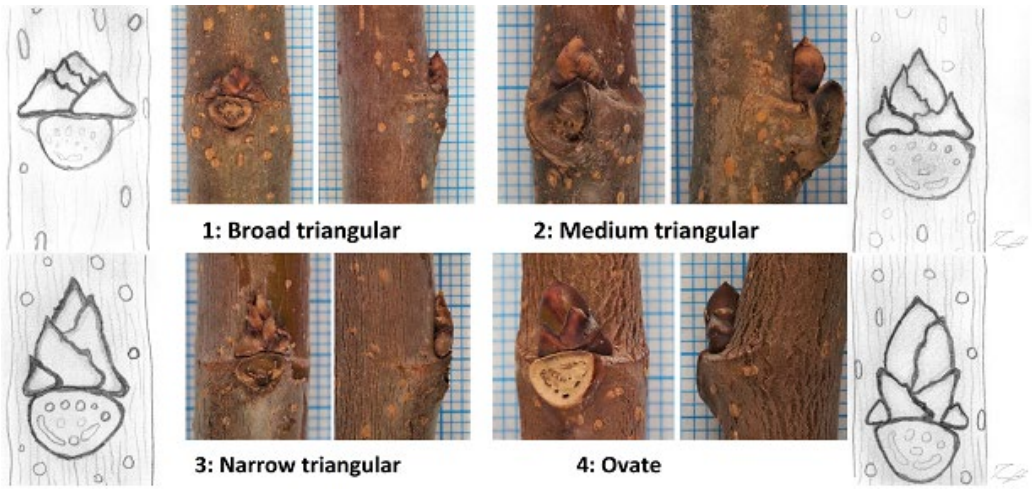




6.3.4 Bud shape (not mandatory)

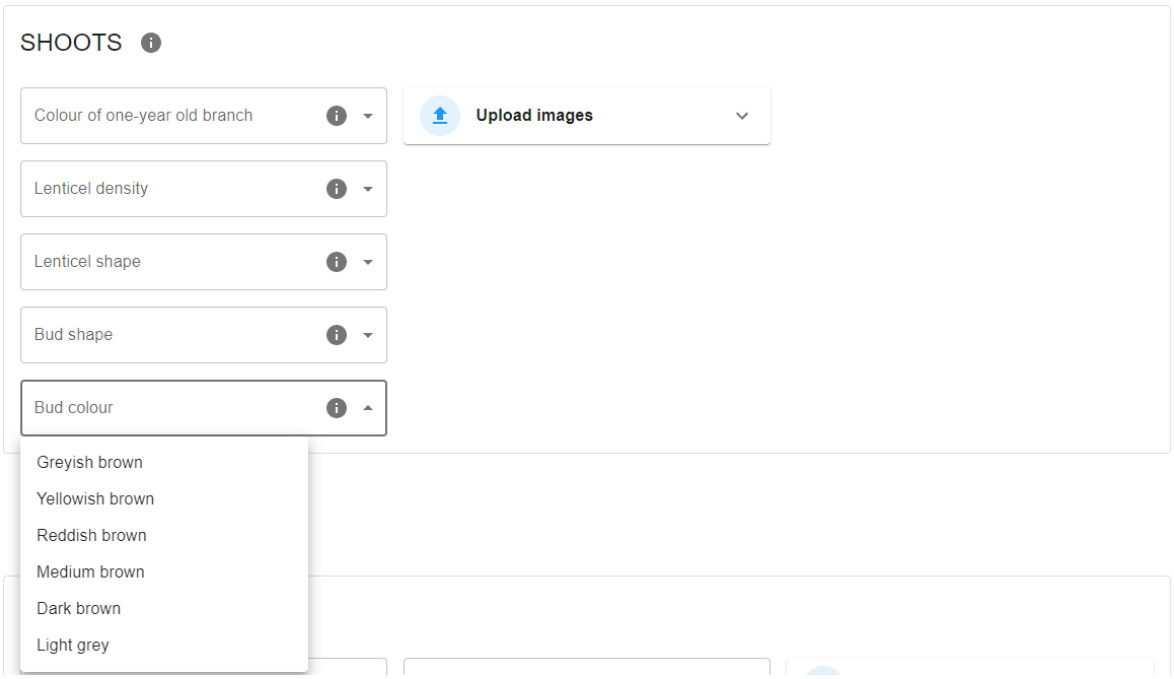
- Broad triangular (Example: Atsubamidori, Filippine, Shin-Ichinose)
- Medium triangular (Example: Cattaneo fem., Florio, Ichinose, Kenmochi, Morettiana)
- Narrow triangular (Example: Wasemidori)
- Ovate (Example: Negoyatakasuke)





6.3.5 Bud colour (not mandatory)

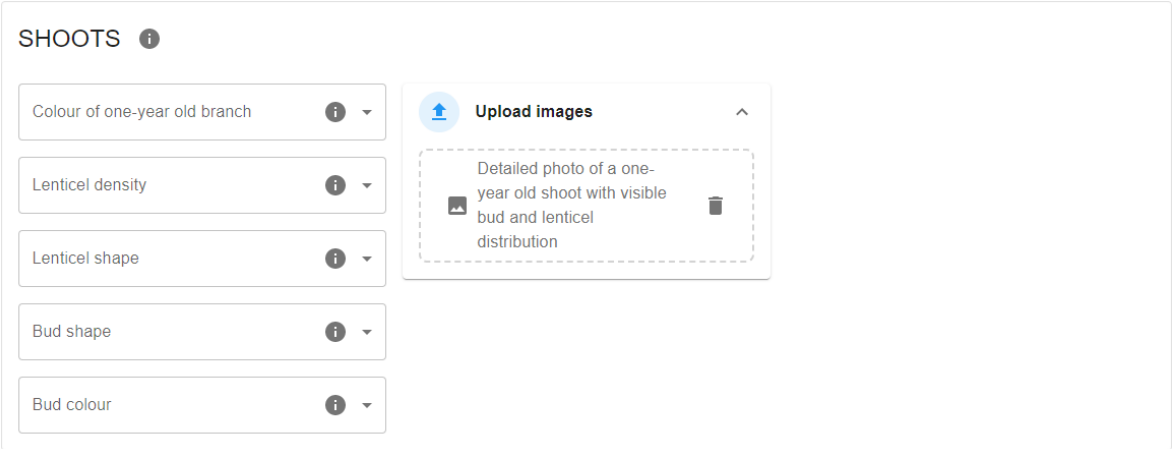
- Greyish brown (Example: Atsubamidori)
- Yellowish brown (Example: Kokuso 27)
- Reddish brown (Example: Ichibei)
- Medium brown (Example: Ichinose)
- Dark brown (Example: Kenmochi)
- Light grey (Example: Shin-Ichinose, Shiromeroso)



1: Greyish brown 2: Yellowish brown 3: Reddish brown 4: Medium brown 5: Dark brown 6: Light grey

6.3.6 Upload images

The user should upload a photo of a shoot, best representing bud and lenticel characteristics (1 photo)

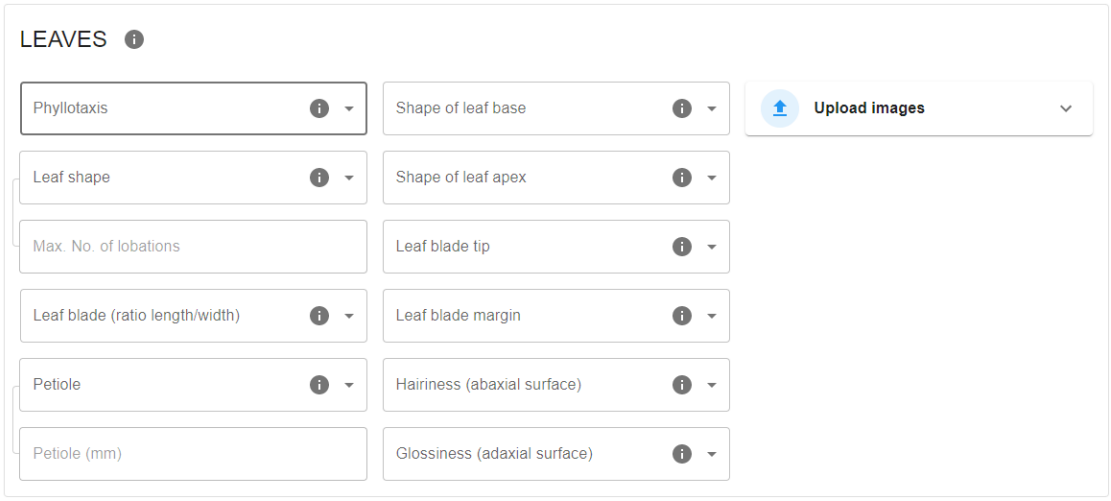


6.4 Leaves

Observations on the leaves should be made on the largest/fully developed leaves on the upper third of the shoots*.

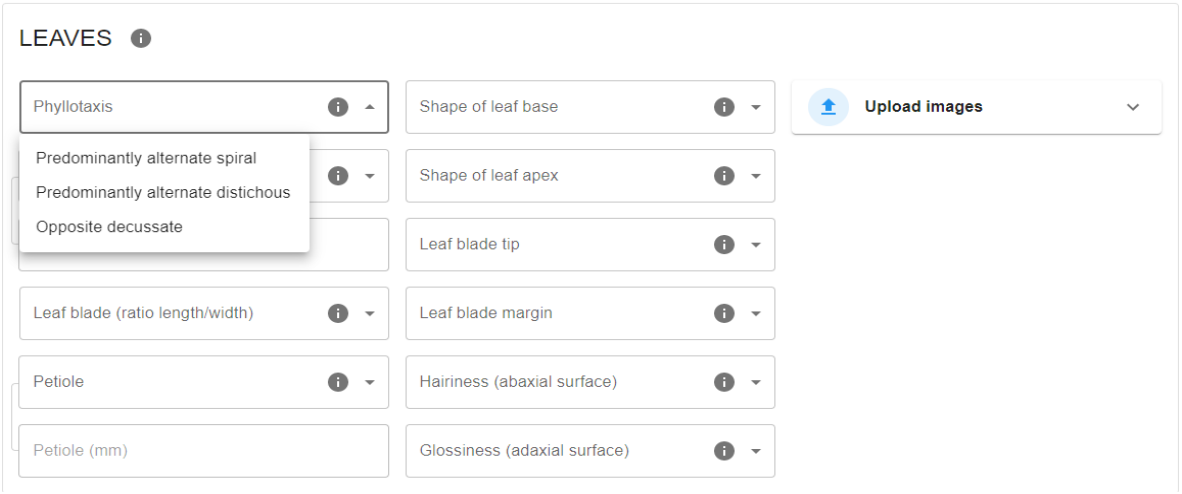
* 1 If the shoots started to grow at the beginning of vegetation period, observations should be carried out from the beginning of July to the mid of September.

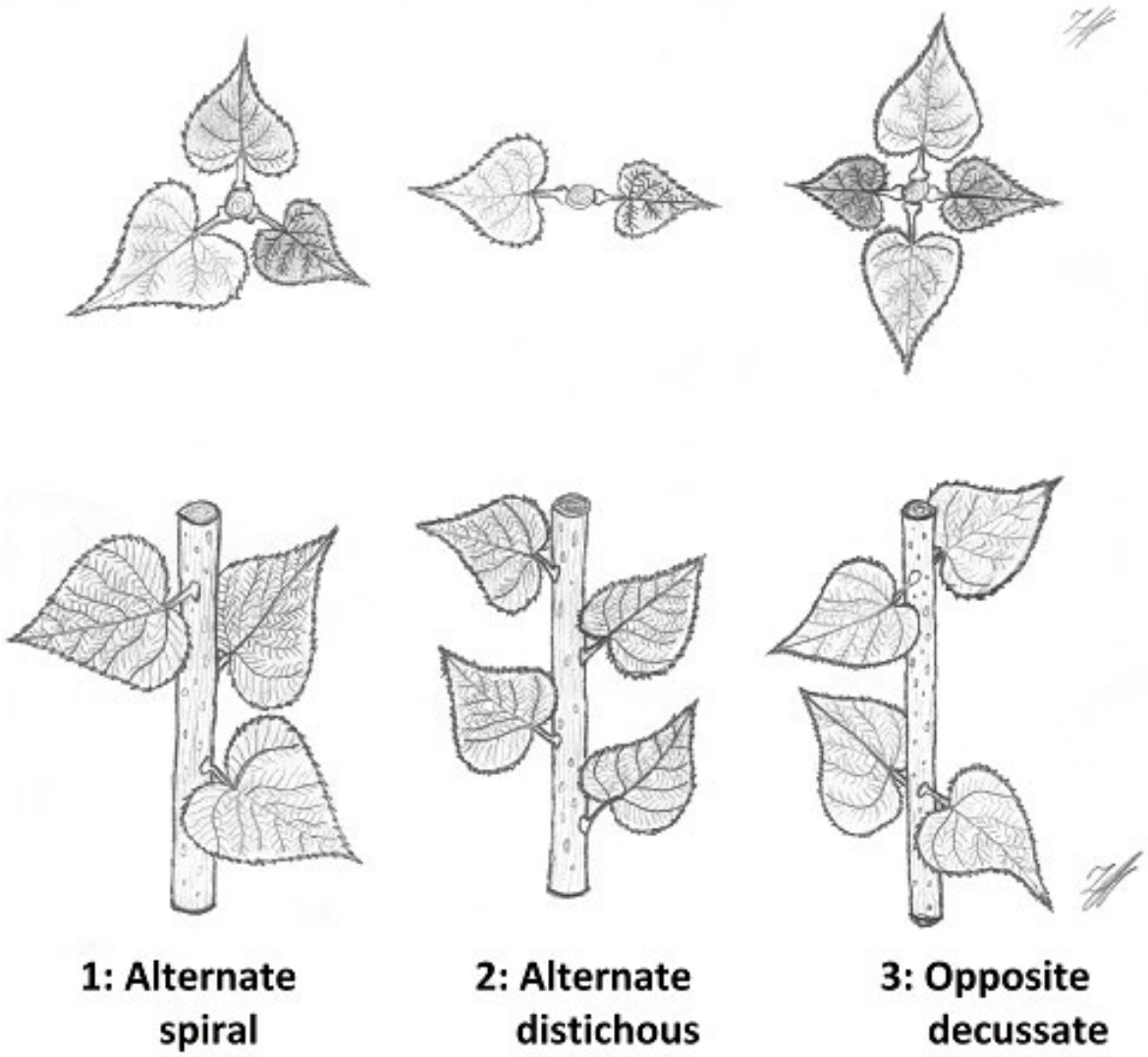
2 If the shoots started to grow after spring harvesting, observations should be carried out in September.



6.4.1 Phyllotaxis (not mandatory)

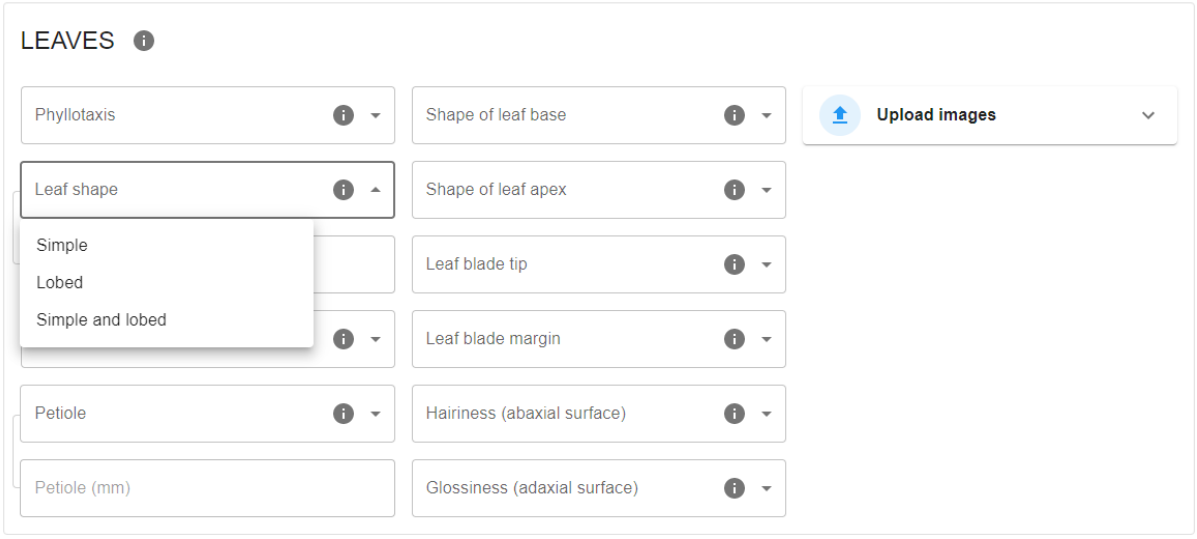
- Predominantly alternate spiral
- Predominantly alternate distichous
- Opposite decussate

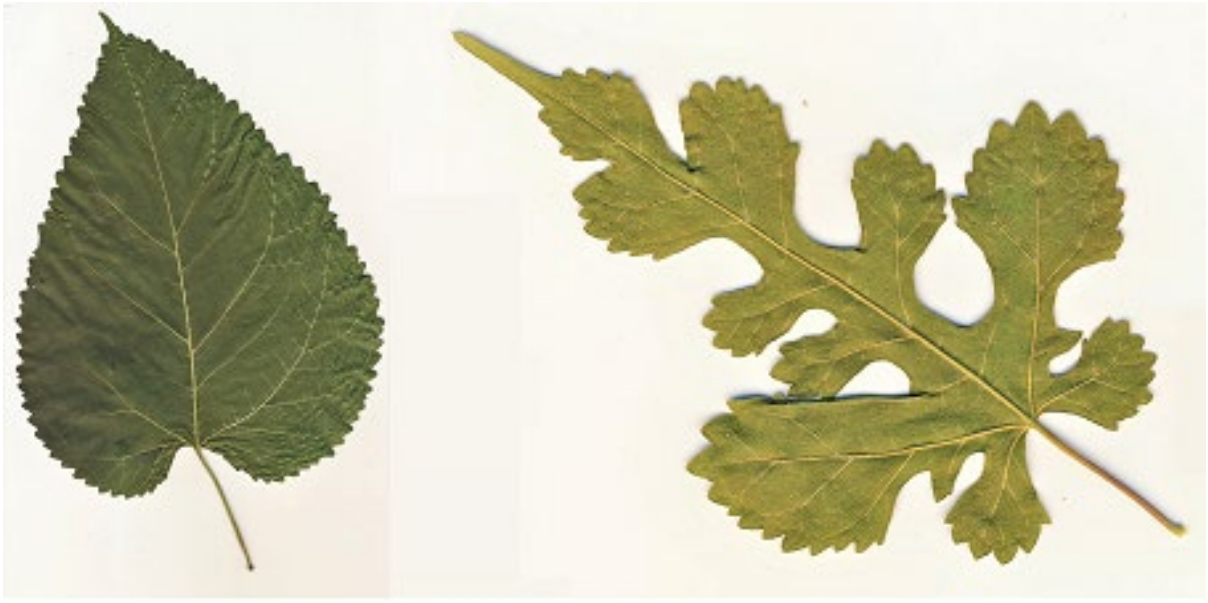




6.4.2 Leaf shape (lobation/heterophylly) (not mandatory)

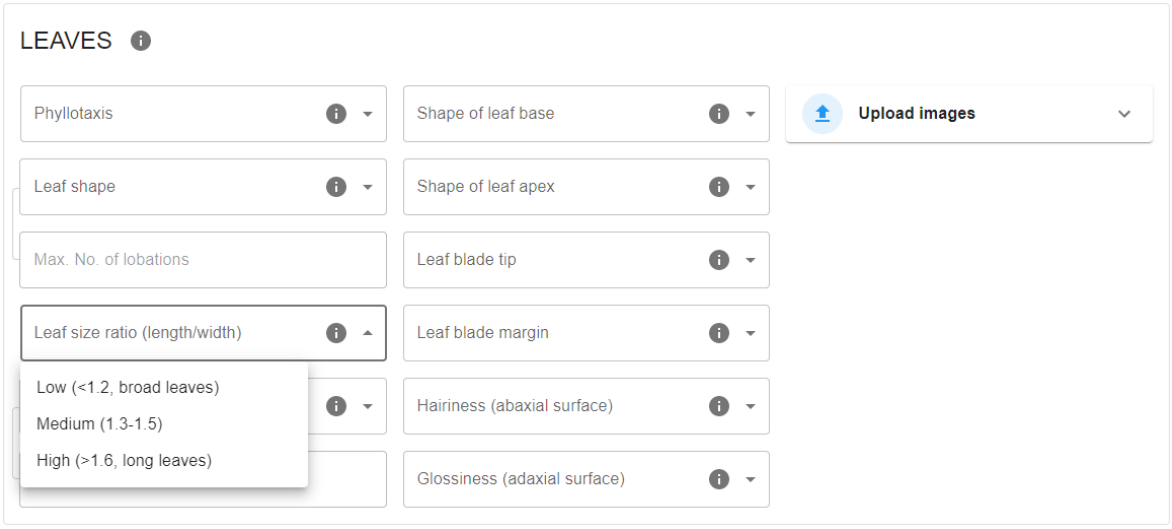
- Simple
- Lobed
- Simple and lobed

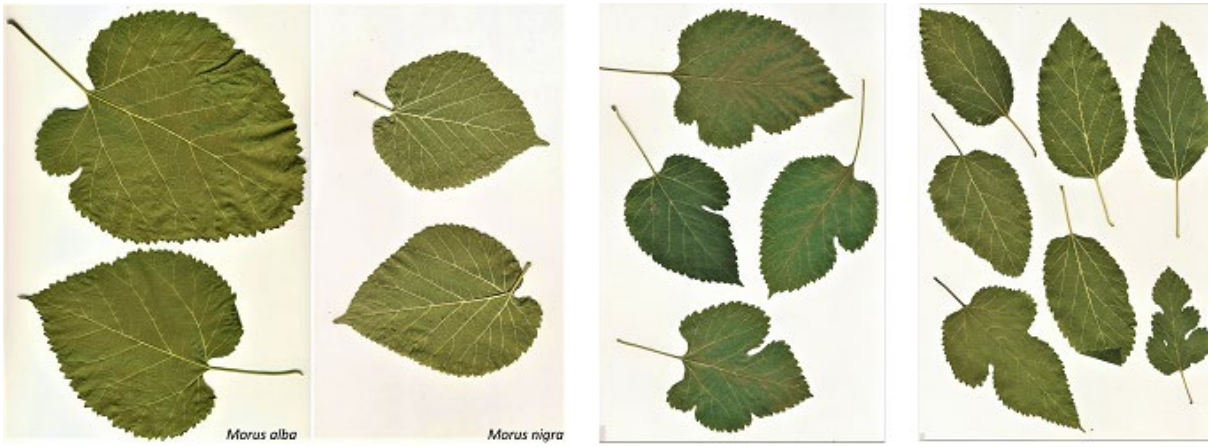




6.4.3 Leaf size ratio (length/width) (not mandatory)

- Low (<1.2, broad leaves)
- Medium (1.3-1.5)
- High (>1.6, long leaves)



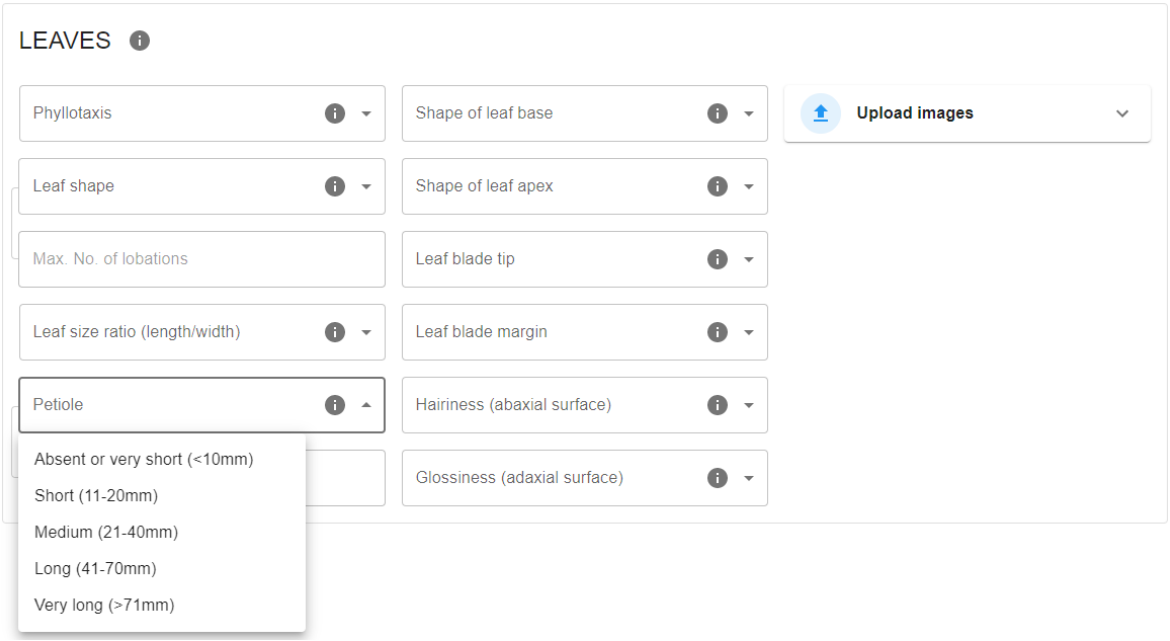


1: Low/broad **2: Medium** **3: High/long**

6.4.4 Petiole (not mandatory)

- Absent or very short (< 11 mm) (Example: Jikunashi)
- Short (11-20 mm) (Example: Queensland Black, Rougetto, Sanchutakasuke)
- Medium (21-40 mm) (Example: Arancina, Ascolana, Ichinose, Kenmochi)
- Long (41-70 mm) (Example: Indiana, Kokka, Shiromekeiso)
- Very long (>70 mm) (Example: Nervosa)
- _____*

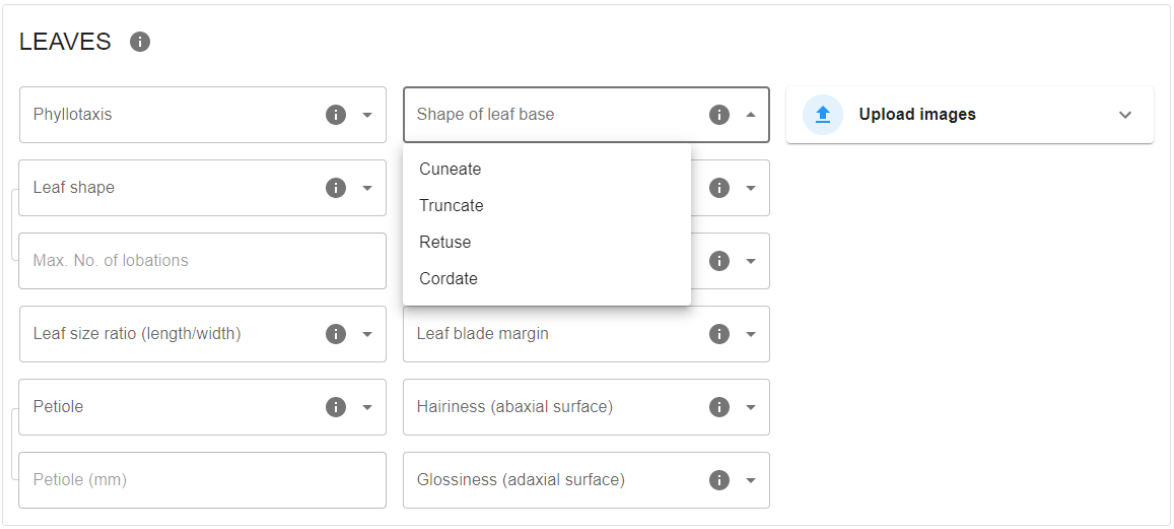
*Entered manually in milimetres (mm)

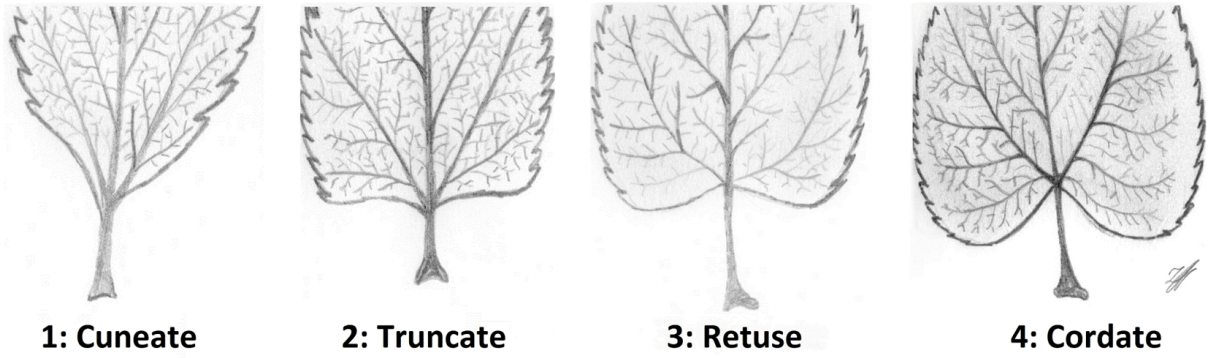


1: Very short/absent **2: Short** **3: Medium** **4: Long** **5: Very long**

6.4.5 Shape of leaf base (not mandatory)

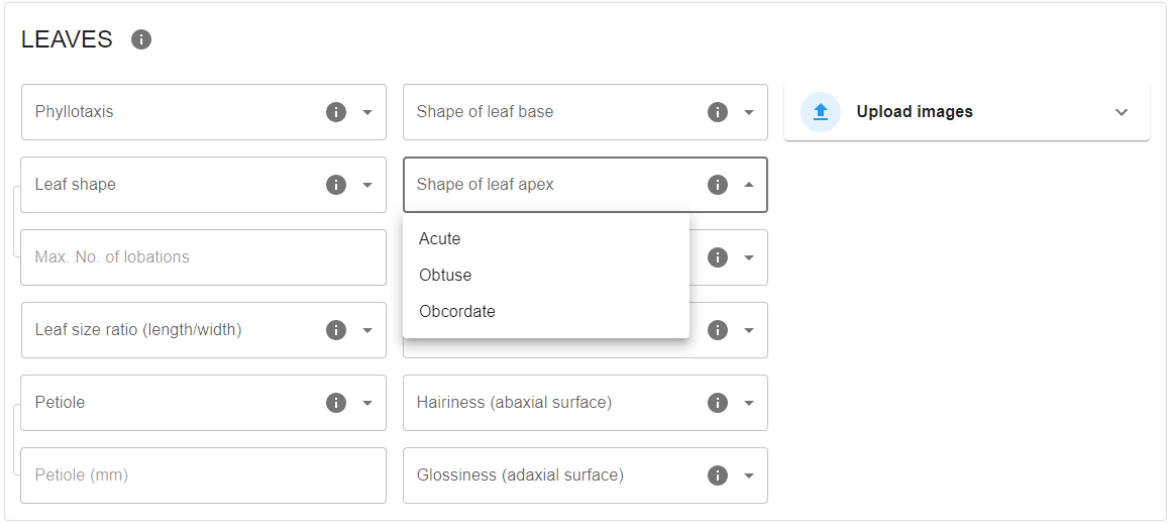
- Cuneate (Example: Nervosa, Popberry)
- Truncate (Example: Goshoerami, Jumonji, Kokuso 70, Negoyatakasuke)
- Retuse (Example: Kenmochi, Restelli, Rosa di Lombardia)
- Cordate (Example: Arancina, Ichinose, Romana rabelaire)

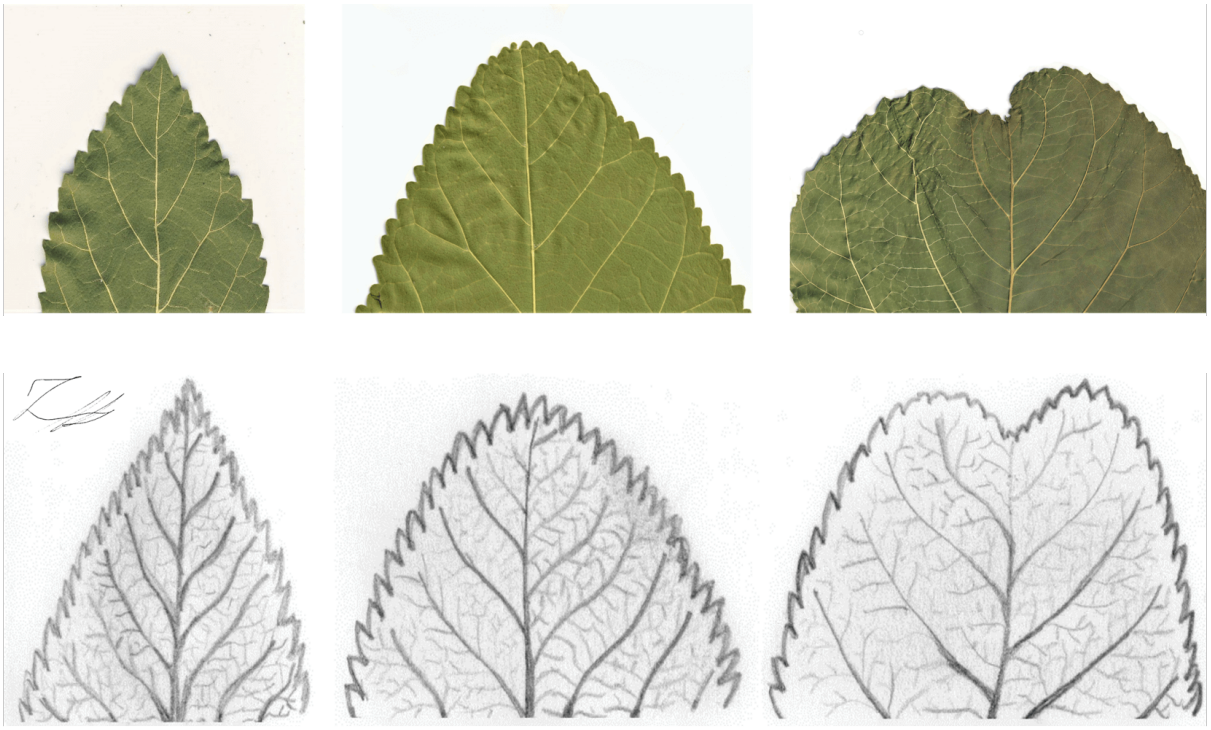




6.4.6 Shape of leaf apex (not mandatory)

- Acute (Example: Ichinose)
- Obtuse (Example: Jikunashi)
- Obcordate (Example: Niken)

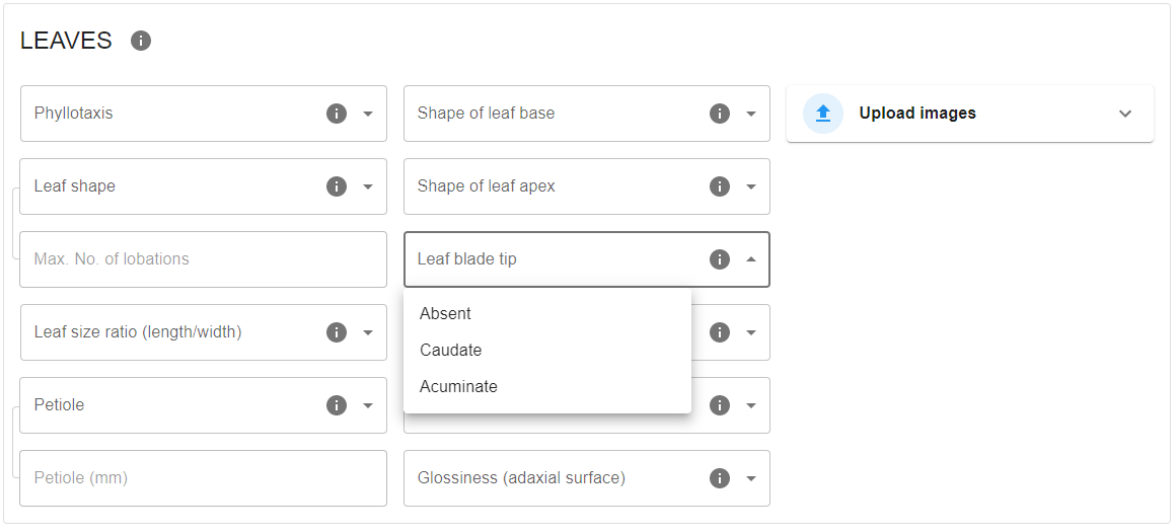


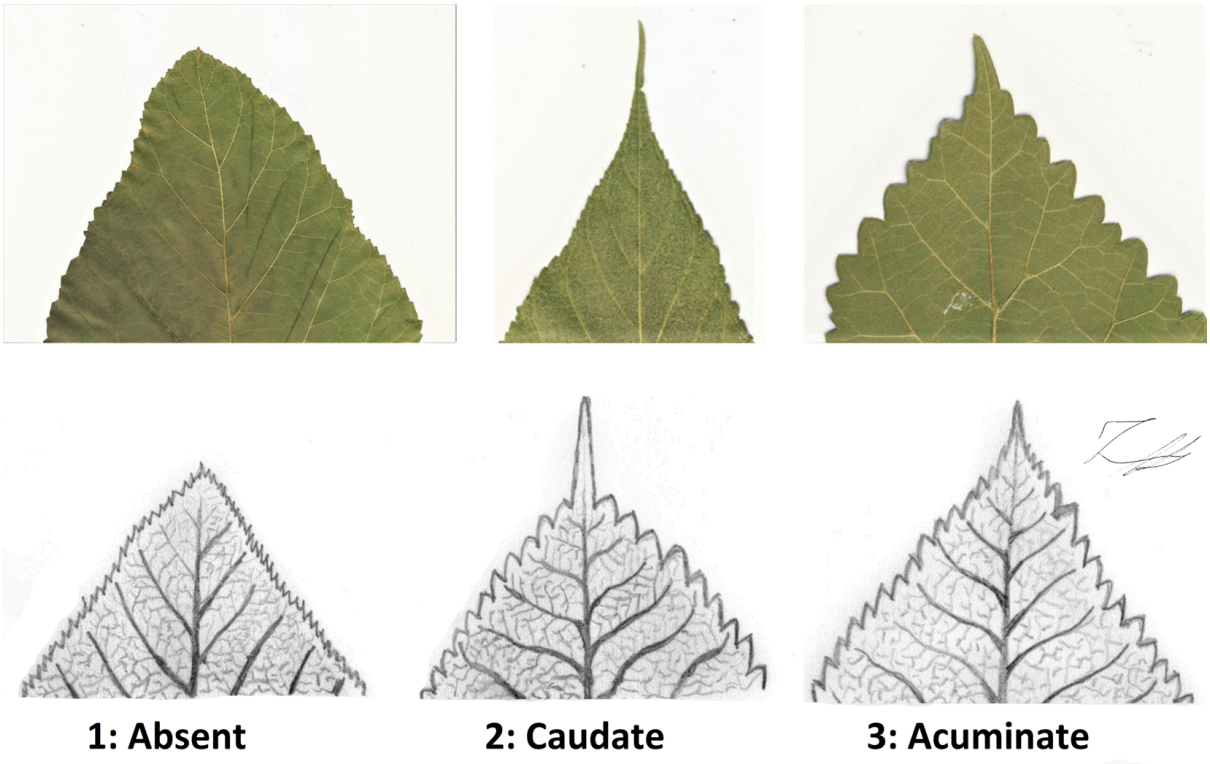


1: Acute **2: Obtuse** **3: Obcordate**

6.4.7 Leaf blade tip (not mandatory)

- Absent (Example: Romana rabelaire, Rougetto)
- Caudate (Example: Ascolana, Florio, Fukayuki, Takinokawa)
- Acuminate (Example: Indiana, Kenmochi, Limoncina)

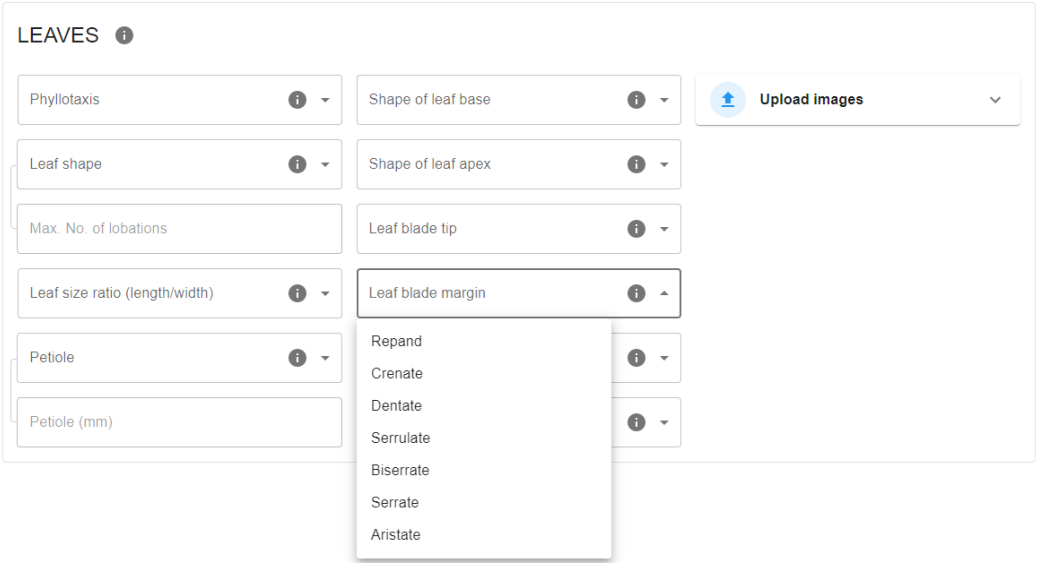


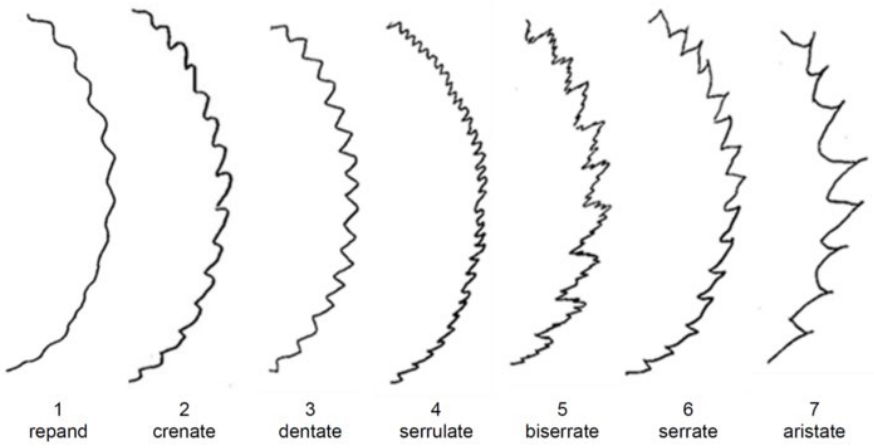


6.4.8 Leaf blade margin (not mandatory)

- Repand (Example: Ichinose)
- Crenate (Example: Kairyo-Roso, Kanmasari, Limoncina, Rougetto, Shin-Ichinose)
- Dentate (Example: Ascolana, Fukushimaoha, Restelli)
- Serrulate (Example: Kenmochi, Oshimaso, Planifolia)

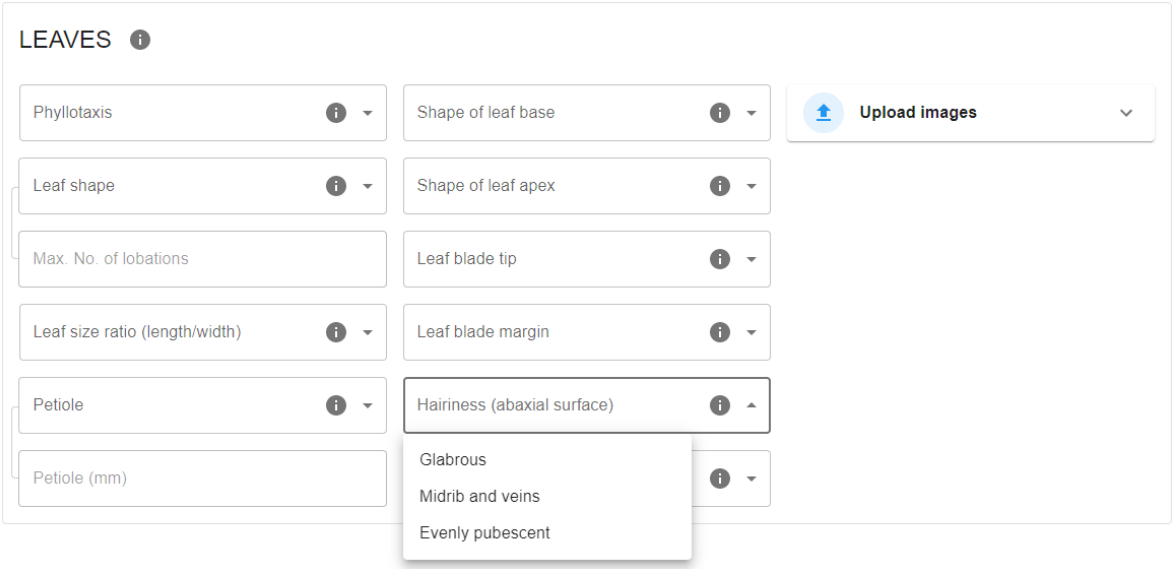
- Biserrate (Example: Florio)
- Serrate (Example: Akameroso, Hicks Fancy)
- Aristate (Example: Nervosa)

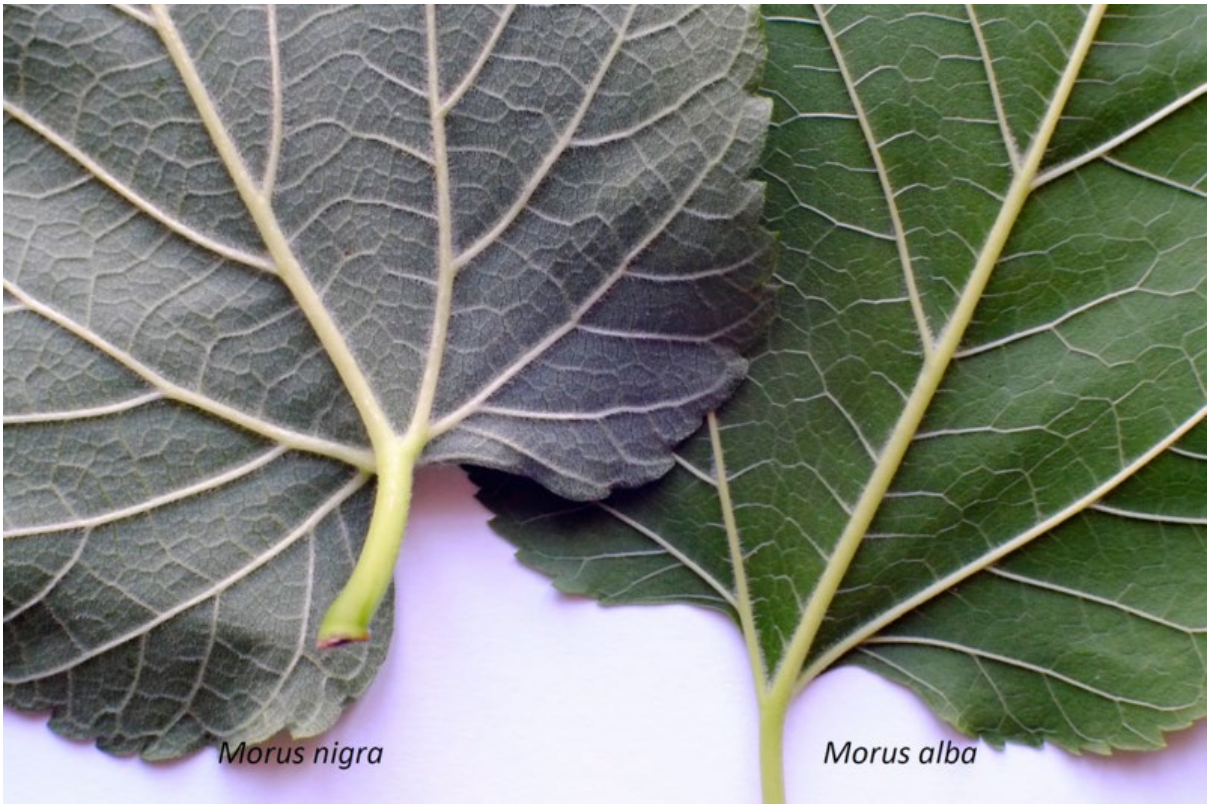




6.4.9 Hairiness (abaxial surface) (not mandatory)

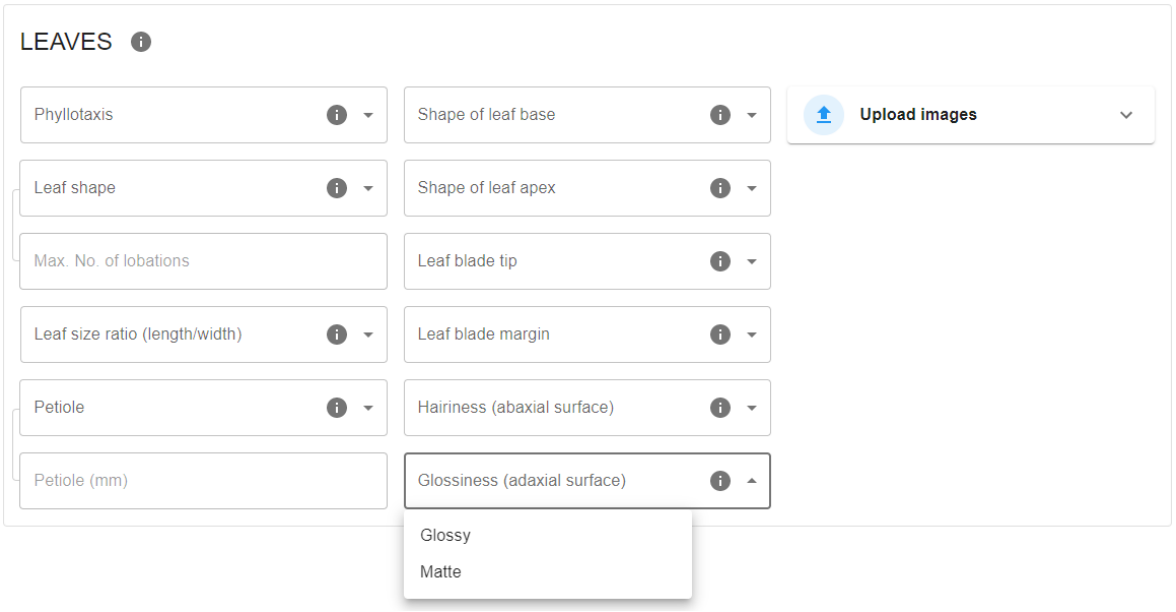
- Glabrous
- Midrib and veins
- Evenly pubescent





6.4.10 Glossiness (adaxial surface) (not mandatory)

- Glossy
- Matt



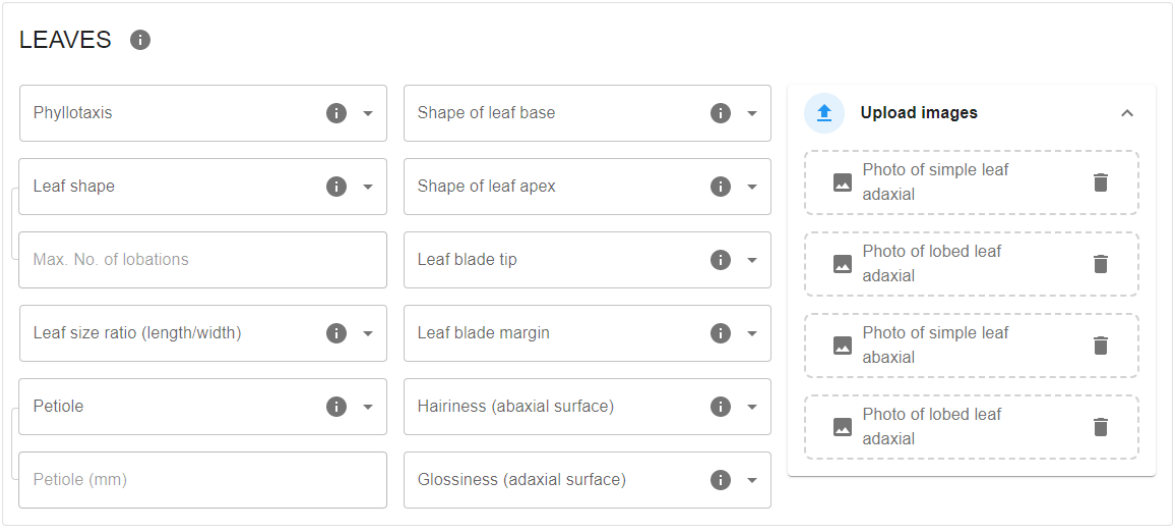
1: Glossy **2: Matt**

6.4.11 Upload images

Leaf photo (whole leaf with petiole, abaxial and adaxial side)* (not mandatory):

* 2 to 4 images will be attached by the user according to the options above:

- Photo simple leaf, adaxial side
- Photo simple leaf, abaxial side
- Photo lobed leaf, adaxial side
- Photo lobed leaf, abaxial side



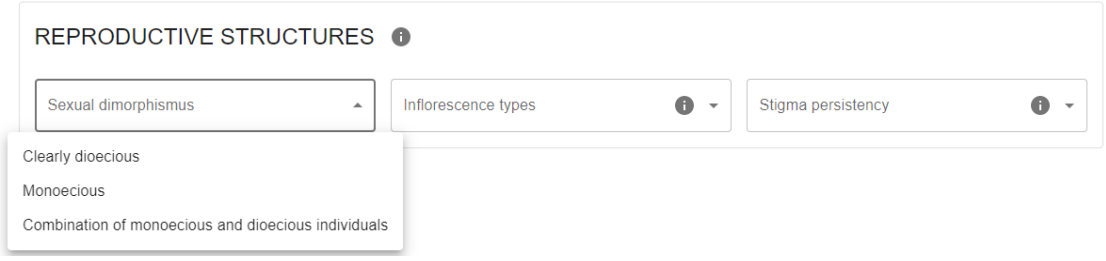
6.5 Reproductive structures

Observations on the inflorescences should be made at the time of full flowering.

6.5.1 Sexual dimorphismus* (not mandatory)

- Clearly dioecious
- Monoecious
- Combination of monocious and dioecious individuals

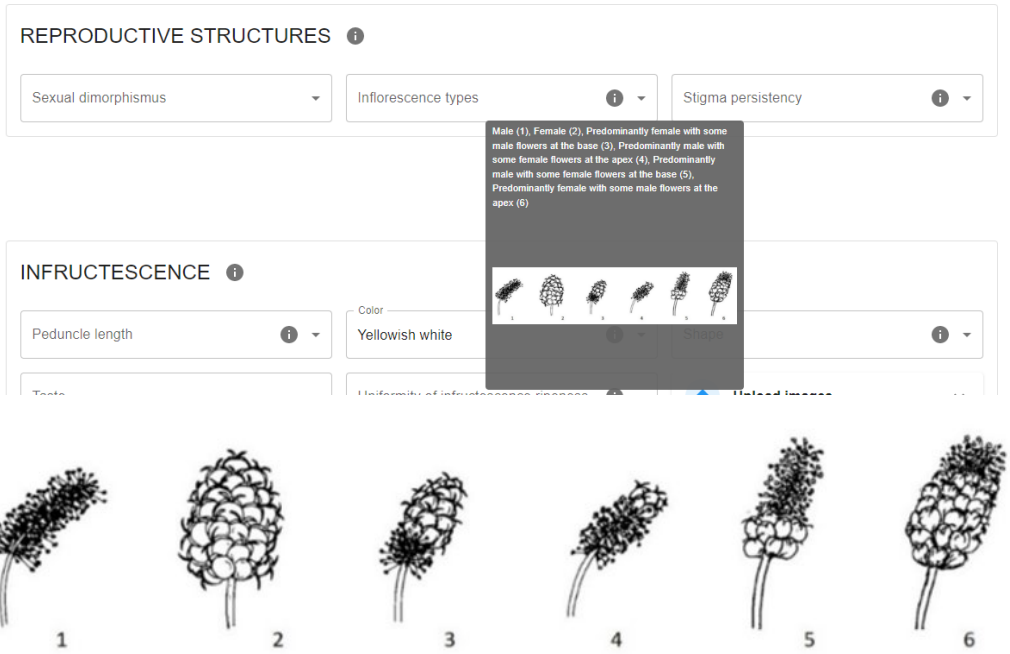
* – **Dioecious**: male and female inflorescence on different individuals, no hermaphrodite inflorescences
– **Monoecious**: female, male, or/and hermaphrodite inflorescences on the same individuals



6.5.2 Inflorescence types* (not mandatory)

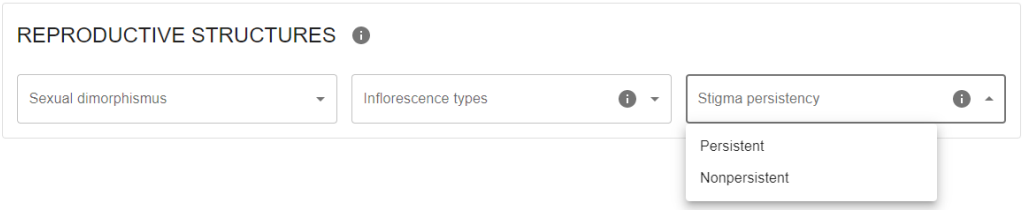
- Male (1)
- Female (2)
- Predominantly female with some male flowers at the base (3)
- Predominantly male with some female flowers at the apex (4)
- Predominantly male with some female flowers at the base (5)
- Predominantly female with some male flowers at the apex (6)

* Chosen from 6 influorescence possibilities, supported by scheme (male, female and 4 hermaphrodite options)



6.5.3 Stigma persistency at fruit ripening process (not mandatory)

- Persistent
- Nonpersistent

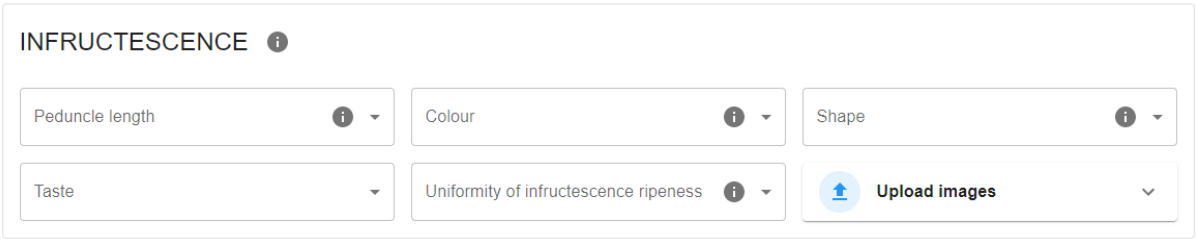


1: Persistent **2: Nonpersistent**

6.6 Infructescence

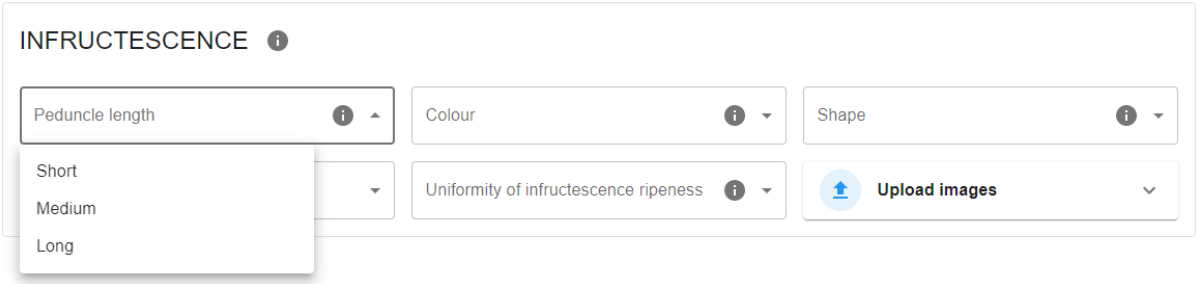
Observations on the infructescence should be made at the time of full maturity.

- The user should upload a photo of infructescence (1 photo).



6.6.1 Infructescence peduncle length (not mandatory)

- Short (Example: Ascolana, Giazzola, Lalaberry)
- Medium (Example: Cattaneo fem., Ichinose, Kenmochi)
- Long (Example: Kozaemon, Platanoide)



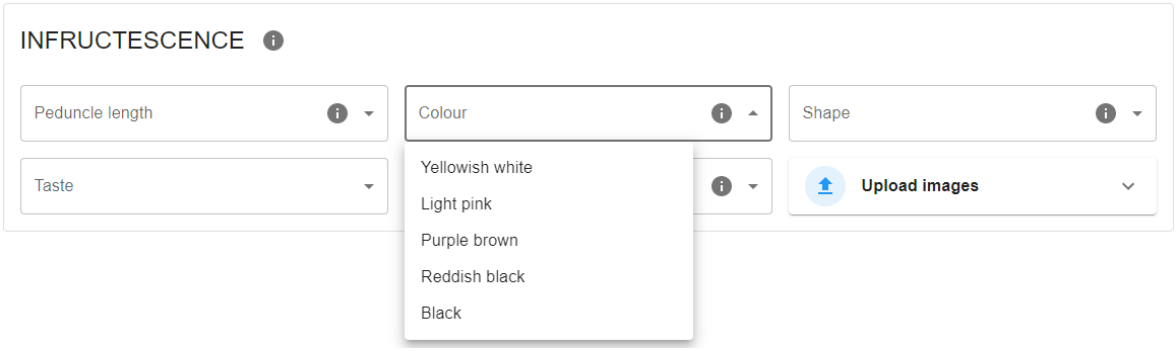
1: Short

2: Medium

3: Long

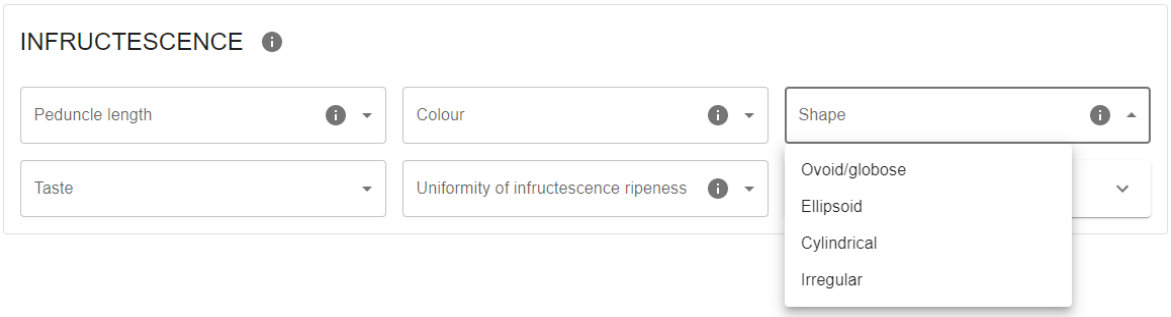
6.6.2 Colour of infructescence (not mandatory)

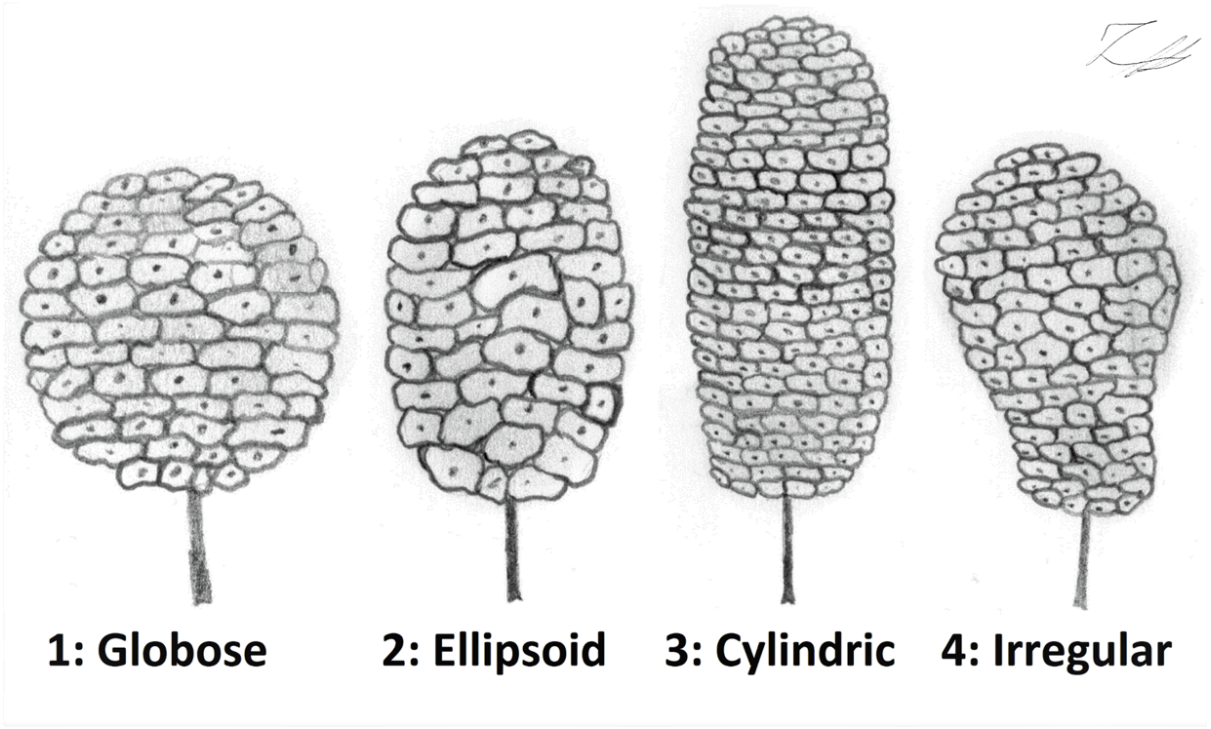
- Yellowish white
- Light pink
- Purple brown
- Reddish black
- Black



6.6.3 Infructescence shape (not mandatory)

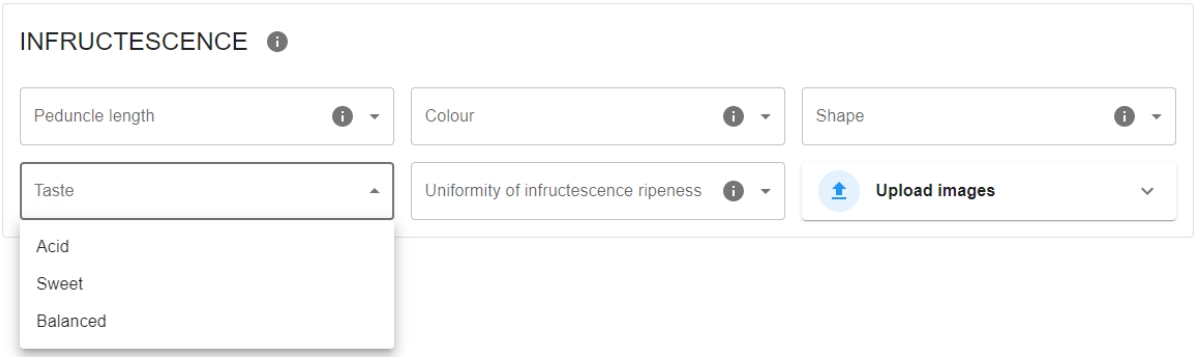
- Ovoid/globose (Example: Piramidale)
- Ellipsoid (Example: Ascolana, Florio, Lalaberry)
- Cylindrical (Example: Cattaneo fem., Ichinose, Kenmochi, Kokka, Platanoide)
- Irregular





6.6.4 Taste of infructescence (not mandatory)

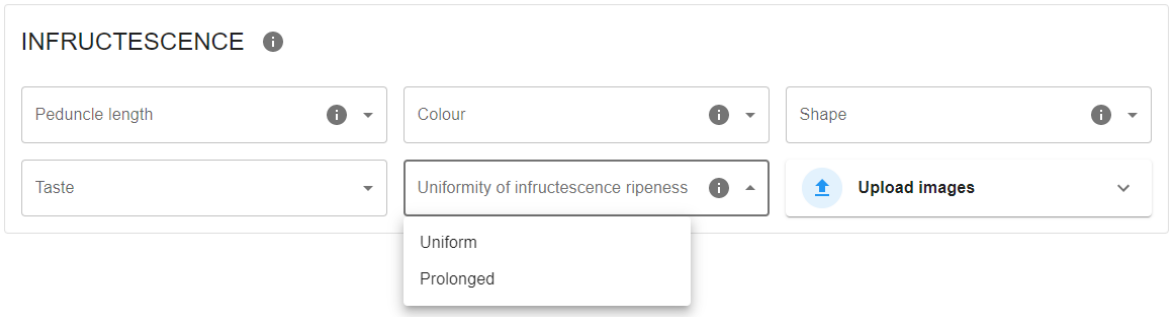
- Acidic
- Sweet
- Balanced



6.6.5 Uniformity of infructescence ripeness* (not mandatory)

- Uniform
- Prolonged

* Ripe means that the infructescences can be easily detached. Prolonged ripeness means that the infructescences can be observed in different stages of development, e.g. from pale green to ivory/light pink; from light red to dark red/black on the same observed specimen.

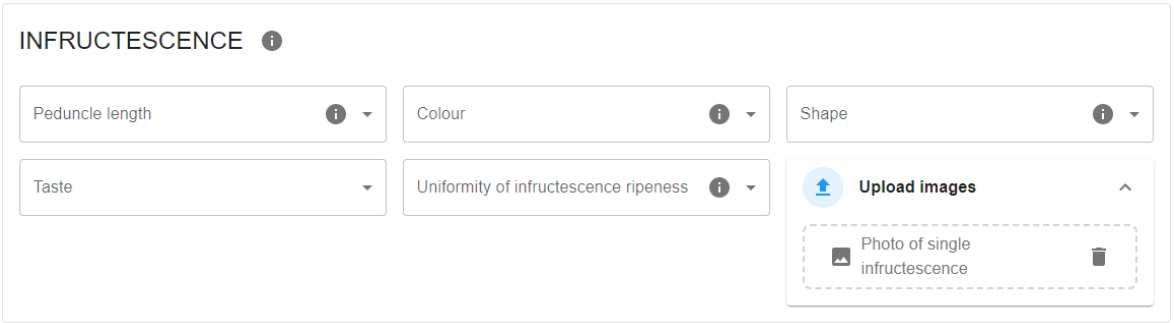


1: Uniform ripeness

2: Prolonged ripeness

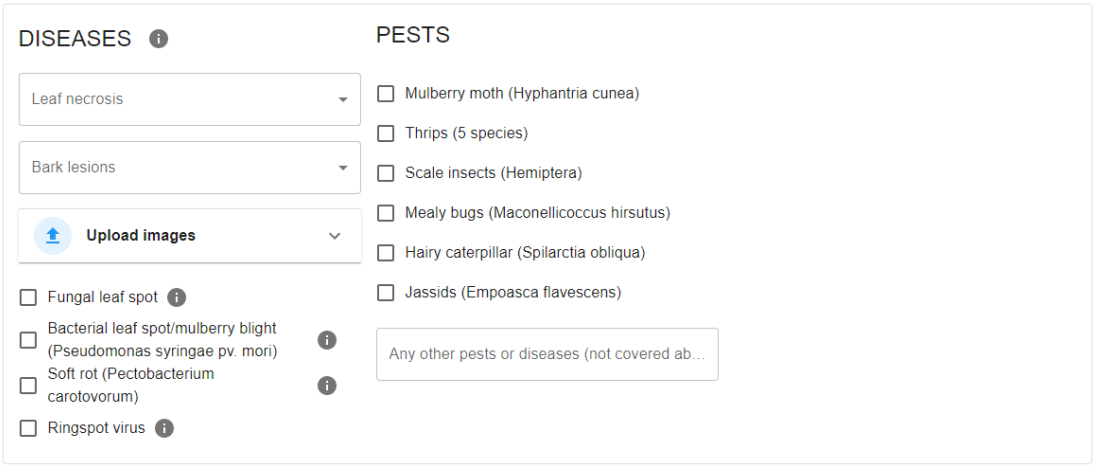
6.6.6 Upload images

The user should upload a photo of a single infructescence (1 photo).



7. Diseases and pests

This section is dedicated to the current diseases and pests affecting the mulberry *Morus* sp. It is shaped according to the current status of the main diseases and pests that occur in the EU and have to be reported to EPPO Pest Reporting. The most important symptoms can be selected via a drop-down menu, certain diseases and pests are offered as checkboxes, so that multiple selections are possible. New diseases can be added via the "Fill in text" option and approved by the general administrator in the main menu.



1: Bark lesions

2: Ringspot virus

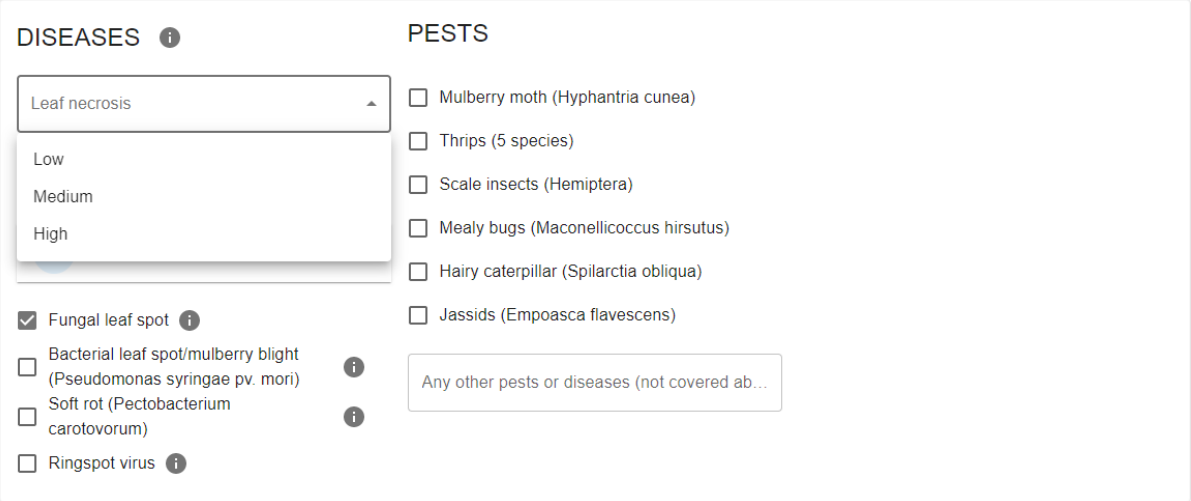
3: Moth

7.1 Diseases (not mandatory)

User should focus on incidence of leaf necrosis and bark lesions symptoms.

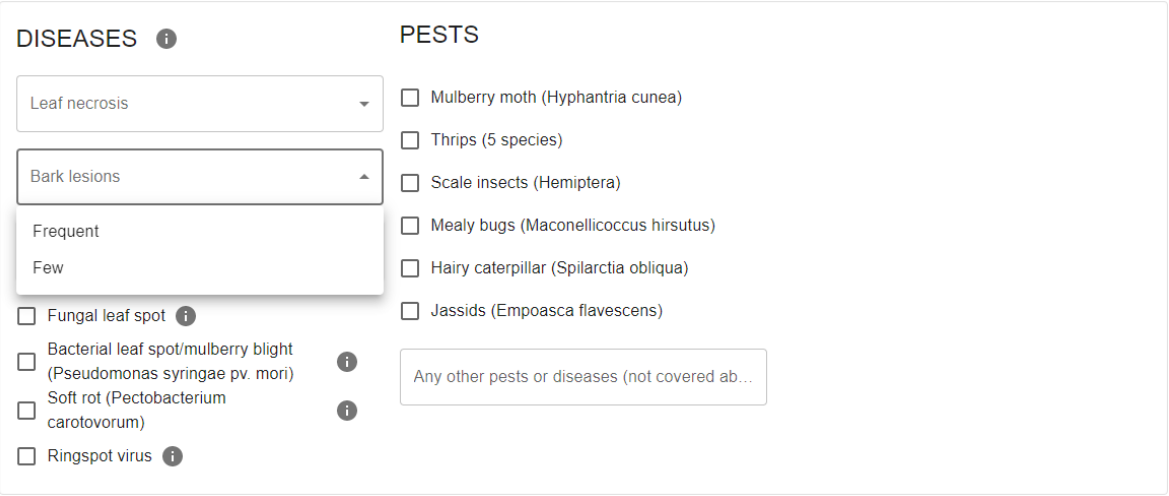
7.1.1 Leaf necrosis

The user should make a decision about the severity of the necrotic leaf lesions.



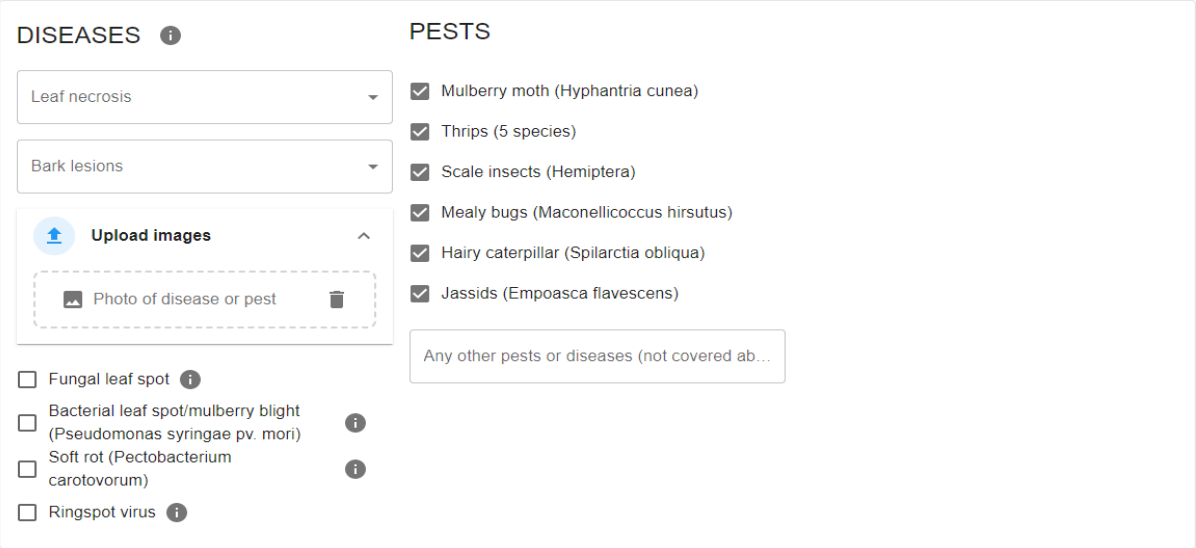
7.1.2 Bark lesion

The user should make a decision about the occurrence of bark lesions.



7.1.3 Upload images

The user should upload a photo of the infected/infested part of the plant, clearly showing all the characteristics of the symptoms/damage (one photo).



Advanced user can also choose among different types of diseases and pests:

7.1.4 Fungal leaf spot

Necrotic spots with light-coloured (whitish) centres and dark margins surrounded by a halo of light green to yellow tissue. Veins become dark. In the centre small pin point black dots can be seen*.

7.1.5 Bacterial leaf spot/mulberry blight (*Pseudomonas syringae* pv. *mori*)

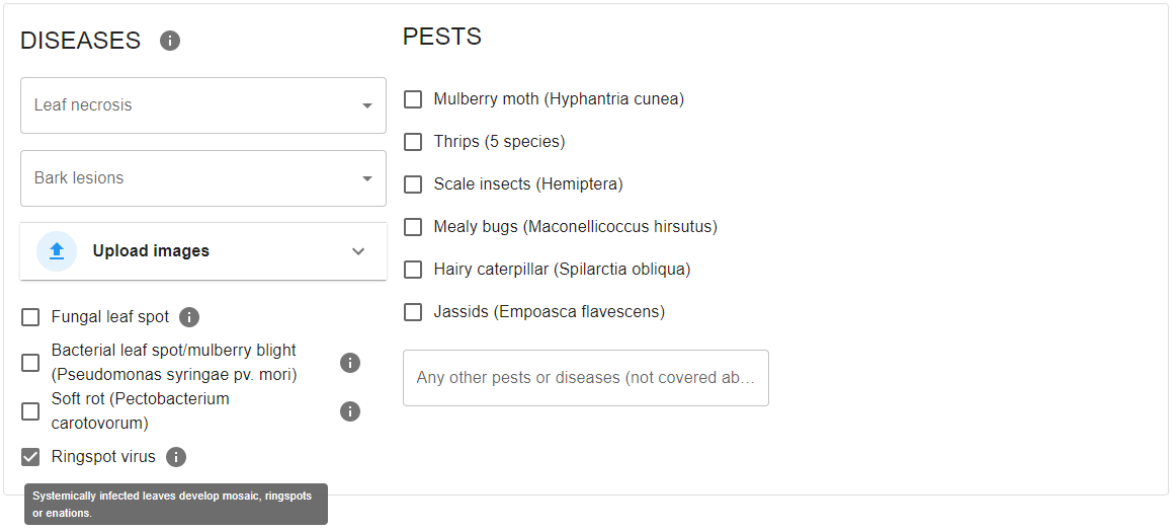
Dieback of the twigs. On the blade, midrib and veins of the young leaves, angular irregularly shaped brown to black spots develop, surrounded by yellow hallo. The rapidly expanding leaves may become curled or distorted. Long ragged cancers develop on the infected young shoots, which often die*.

7.1.6 Soft rot (*Pectobacterium carotovorum*)

Nonsprouting of the overwintering shoot in early spring and soft rot of the young shoot in middle or late spring*.

7.1.7 Ringspot virus

Systemically infected leaves develop mosaic, ringspots or enations*.



7.2 PESTS (not mandatory)

7.2.1 Mulberry moth (*Hyphantria cunea*)
7.2.2 Thrips (5 species)
7.2.3 Scale insects (*Hemiptera*)
7.2.4 Mealy bugs (*Maconellicoccus hirsutus*)
7.2.5 Hairy caterpillar (*Spilarctia obliqua*)
7.2.6 Jassids (*Empoasca flavescens*)
7.2.7 Any other pests (not covered above):

- _____*

* Example of input field; manual entry

ACRONYMS

[CBO]	Circumference of the specimen is taken at breast height
[EPPO]	European and Mediterranean Plant Protection Organization
[EU]	European Union
[GPS]	Global Positioning System
[ID]	Identification

References

1. UPOV, INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS, Mulberry, *Morus* L., UPOV Code: https://www.upov.int/meetings/en/doc_details.jsp?meeting_id=55671&doc_id=501796
2. EURISCO: https://eurisco.ipk-gatersleben.de/apex/eurisco_ws/r/eurisco/home
3. Grin Global: https://npgsweb.ars-grin.gov/gringlobal/descriptors
4. iNaturalist (registration needed): https://www.inaturalist.org/observations/139346065
5. IPNI-International Plant Names Index: https://www.ipni.org/
6. KEW Plants of the World online: https://powo.science.kew.org/