GREENPATROL – GA 277663

Galileo Enhanced Solution for Pest Detection and Control in Greenhouse Fields with Autonomous Service Robots

D2.3 Version 2.0

Sensor Measurements in the operating environment – Public Version

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Abstract:

The present document contains the public version of the description of the set of measurements gathered with navigation and perception sensors in real environment with the purpose to assess the performance of the sensors to be selected.

Document Control

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Executive Summary

This document is the public version of the deliverable GreenPatrol D2.3 Sensor Measurements in the operating environment.

GreenPatrol Deliverable 2.3 consists on a set of measurements gathered with the navigation and perception sensors. This document serves as a reference guide that describes the format and location of these measurements.

Data has been collected during different experiments and measurement campaigns that were carried out to assess the performances of the navigation and inspection sensors in real operating conditions.

The set of measurements are split into two collections: On the one hand, a collection of data gathered from the sensors used for mobile platform navigation. On the other hand, a set of images taken from the cameras used for monitoring plants and pests.

Both data collections are publicly available under request via the following email address:

info@greenpatrol-robot.eu

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List of Acronyms and Abbreviations

Term	Description
AHRS	Attitude and heading reference system
AltBOC	Alternate Binary Offset Carrier
COTS	Commercial Off The Shelf
DR	Dead reckoning
GNSS	Global Navigation Satellite System
IMU	Inertial measurement unit
INS	Inertial Navigation System
IPM	Integrated Pest Management
LiDAR	Laser Imaging Detection and Ranging
PPK	Post-Processed Kinematic
PPP	Precise Point Positioning
SD	Secure Digital

1. Introduction

The present document contains a description of the data collected during the tests described in deliverable *D2.2 Sensors Configuration and Specification*.

The collected data are divided into two groups: the first contains the data of the sensors involved in **the robot localization and navigation**, whereas the second is built of images taken for **pest inspection**, which are obtained both from the experiments at a cultivation chamber and in the intended greenhouse environment.

The main objectives within the tests regarding localization and navigation sensors are:

- To **gather data from *testing* navigation sensors** (GNSS, INS, Odometry…) that will serve as example data.
- To allow a detailed analysis of measurement quality in the greenhouse to **study the advantages of the use of Galileo E5 AltBOC** and how it can help in the future solution.
- To retrieve example data from representative scenarios that we can use to **help in development and testing of the processing algorithms** that will be developed in the next phases of the project.

The main objectives within the pest inspection tests are:

- To **gather a large set of images of infested and healthy plants** that will be used to train and test classification algorithms.
- To determine the best **sensor configuration and disposition** inside the robot, as well as relative to other subsystems.

1.1 Purpose and scope

The purpose and scope of this document is to report on the results of the measurement campaign carried, which aims at assessing sensors performances in a real operating environment. The data collections for the different sensors as well as image data base are publically available under request via the following email address:

info@greenpatrol-robot.eu

1.2 Intended audience / Classification

This is a Public document, intended for the Scientific Community with interest in real scenario data collections of different Navigation Sensors in a Greenhouse and/or Image Database containing *T. absoluta, B. tabaci, T. vaporariorum* pests on Tomato plants.

1.3 Reference documents

Inputs from the following documents were used as reference for preparing this document:

Table 1-1: Reference documents

REF	Document
RF-01	RINEX The Receiver Independent Exchange Format Version 3.03

RF-02	D2.2 Sensors configuration and specification
RF-03	Foote, T. (06 de 09 de 2013). *ROS bag format.* Obtenido de http://wiki.ros.org/Bags/Format/2.0

1.4 Application documents

Inputs from the following documents were used as a source of information for preparing this document:

Table 1-2: Application documents

REF	Document
AD-01	Grant Agreement-776324-GREENPATROL

1.5 Document structure

The document structure is as follows:

- Section 2 briefly describes the scenarios and tests performed during the measurement campaign.
- Section 3 describes the format used when collecting data from each component.
- Section 4 contains the codification of the files generated during the static and dynamic tests performed in a tomato greenhouse in Lezama.
- Section 5 contains the codification of the pictures generated during the tests performed in the cultivation charms and in a tomato greenhouse in Lezama.

2. Experiments and Tests description

This section briefly describes the scenarios and tests performed during the measurement campaign. For a detailed description see RF-02.

2.1 Navigation assessment tests

The navigation assessment tests were performed on February 2018 in a group of greenhouses located in Lezama, Bizkaia (Spain). Tests were performed in an aluminum and crystal building with rectangular shape and gabled roof where the plants grow in rows perpendiculars to the longest side. The greenhouse has also an aluminized thermal curtain system used during too sunny or cold weather to provide shading or thermal protection.

Figure 2.1: Greenhouse test site

A Segway® FLEX OMNI COTS robotic platform has been used in the tests. Apart from the already available sensors carried by the platform, additional navigation sensors have been mounted on. The following table summarizes the set of sensors used during the tests.

Table 2-1: Navigation sensors list

Sensor	Notes
GNSS Multiconstellation receiver	Only for test Development kit allows data collection saving in SD
Laser Imaging Detection and Ranging	Embedded in the platform
Odometry	Embedded in the platform
Inertial Measurement Unit	Embedded in the platform
Low cost GNSS+DR	Only for test
Low cost INS	Only for test. Included for backup
Static reference GNSS. **GNSS Multiconstellation receiver**	Only for test Installed outdoor with good open sky visibility
GPS receiver with integrated antenna	Only for test An additional GNSS receiver is

	used in order to add GPS time stamps to the measurements gathered by the sensors embedded in the robotic platform, and be able to synchronize them with the rest of the sensor readings.

As a position reference system, a laser tracker was installed in the greenhouse during the tests.

Several test sets have been considered with the purpose of covering all the possible conditions that could affect the performance of the system. Static/dynamic, curtain on/off, indoor/outdoor, and different positions inside the greenhouse are taken into account.

Due to the time required for each test, and to allow some set-up time and contingency, tests were divided in different days: static tests (which are mainly used to assess data quality) on one day, and dynamic tests (which are mainly used to assess positioning performance) on a different day.

The following table summarizes the tests (see RF-02 for description of the test):

Table 2-2: Test summary

	Test 1	Test 2	Test 3	Test 4	Test 5
Movement	Static	Static	Dynamic	Dynamic	Dynamic
Curtain	-	On/Off	Off	Off	Off
In/Out	Outdoor	Indoor	Indoor	Indoor	Outdoor/Indoor
Positions	Nearby greenhouse	Inside greenhouse	Inside greenhouse. Reference points at main corridor.	Inside greenhouse. Reference points at main corridor.	Inside greenhouse. Reference points at main corridor.
Logged data	GNSS	GNSS	GNSS IMU Odometry LiDAR	GNSS IMU Odometry LiDAR	GNSS IMU Odometry LiDAR Base station

2.2 Pest inspection experiments

Regarding the pest inspection tests, images have been taken both in a cultivation chamber and in Lezama Greenhouse. Completely enclosed boxes have been used for tomato cultivation, placed in a cultivation room isolated from outside conditions. These growth boxes allow eliminating both external and internal factors (contamination by other pathogens). An imaging system with four LED lights and different types of cameras has been used for monitoring tomato plants and pests. The cultivation and grow chambers and the imaging system are shown in the following figure:

Figure 2.2: Cultivation and grow chambers and imaging system

First cultivation was started on November 2017, and new seed were planted every week to obtain different development phases. The pictures of plants were taken weekly by different settings of cameras. At the same time, cultivation of individual pathogens from contaminated soil was started. The initial plant infestation attempts did not succeed even after several repetitions of cultivations. Because of this, honeybee debris from its sticky board were applied to simulate infection by eggs.

On February 2018 images of healthy and infested tomato plants were taken in Lezama Greenhouse. MENDELU took advantage of her visit to the Greenhouse to get some samples of infested leaves and soil that have been used to successfully infest new plants in the cultivation chambers.

The following table summarizes the cameras used during the tests.

Table 2-3: Camera list

Camera	Notes
JAI's AD-130GE	3CCD camera
MII - G1-2000	black and white camera (16 bits)
MII – DataCam2016	black and white camera (16-8 bits) with artificial light (R, G, B, NIR)
JAI's Gev-AP-3200T-PGE	3CMOS camera

3. Data collection format

3.1 Images

A file naming convention has been adopted for all the pest inspection images that are being captured in the project. This enables us to embed relevant information in the name of the file. Every image file name will have the following structure:

idPlant_idLocation_illumination_idCamera_idSpectral_idFilter_datetime.FORMAT

where,

- *idPlant*: the plant unique identifier (1→tomato, 2→pepper, …)
- *idLocation*: the place where picture has been taken (1→Lezama's greenhouse, 2→Mendelu, 3→Tekniker, …)
- *illumination*: the presence of artificial light (1→No, 2→Yes)
- *idCamera*: The camera unique identifier (1→ GigE UI-5240CP, 2→ JAI's AD-130GE, 3→ Nikon 5300, 4→ MII - G1-2000, 5→ Moravian DataCam 2016)
- *idSpectral*: Spectral area where the image was taken (1→VIS integral, 2→Spectral bands R, 3→Spectral bands G, 4→Spectral bands B, 5→NIR)
- *idFilter*: Type of detector (1→Without any filter, 2→With Bayer filter mosaic)
- *datetime*: Date and time (UTC) is used with the following format: YYYYMMDD-hhmmss (For example: 20180129-154453)

An example of a valid image name: **1_2_2_2_2_1_20180316-135612.tif** (A tomato plant image taken at Mendelu with artificial light, using a JAI's AD-130GE camera, in R spectral area, without any filter, March 16th, 2018 at 13:56:12).

3.2 GNSS multiconstellation Receiver

This data is be logged in binary format and converted to the following RINEX 3.03 files containing for each epoch the main observables such as pseudorange, cycles and Doppler (see RF-01). The binary files can be processed using the utility provided by the manufacturer.

3.3 Static reference GNSS

This data is be logged in binary format (.gps files) and converted to the following RINEX 3.03 files containing for each epoch the main observables such as pseudorange, cycles and Doppler (see RF-01). The binary files can be processed using the utility provided by the manufacturer.

3.4 GPS USB

Data from the sensor GPS USB is contained in CSV files with the following content:

```
timestamp      UTC_time
```

This sensor is used just to link the Robot time and UTC from GPS.

3.5 AHRS UM7

Data from the sensor UM7 is contained in CSV files with the following content:

```
timestamp      orientation_roll      orientation_pitch     orientation_yaw
       angular_vel_x  angular_vel_y  angular_vel_z  linear_acc_x   linear_acc_y
       linear_acc_z   orientation_x  orientation_y  orientation_z  roll    pitch   yaw
       temperature
```

To translate the timestamp given value to GNSS time, a join with timestamp from GPS USB data must be done.

3.6 Odometry

Data from the odometry is contained in CSV files with the following content

```
Timestamp, pose_x, pose_y, pose_z, roll, pitch, yaw, linear_twist_x, linear_twist_y,
linear_twist_z, angular_twist_x, angular_twist_y, angular_twist_z
```

To translate the timestamp given value to GNSS time, a join with timestamp from GPS USB data must be done.

3.7 Velodyne laser

The LiDAR data is collected as binary data, as it would become unmanageable if it were imported to CSV. It is recorded as a ROS *bag* file format version 2.0, the primary mechanism in ROS for data logging (Foote, 2013).

The following table shows all the recorded topics related to the laser data:

Topic name	Message type	Description
/segway/filtered_scan	sensor_msgs/LaserScan	/segway/scan_3d data applying the following filters: - Scan shadows: removes laser readings that are most likely caused by the veiling effect when the edge of an object is being scanned. - Range filter: removes readings farther than 18m - Scan intensity filter: remove readings whose intensity is low. - Footprint filter: remove readings that lie inside the robot footprint.
/segway/scan_3d	sensor_msgs/LaserScan	Velodyne raw data converted into 2D laser data format applying the following filters: - Considered vertical data: 0.05m to 1m from the ground - Considered horizontal data: -180º to 180º being 0º the the angle facing the head of robot. - maximum range: 40m

/velodyne_packets	velodyne_msgs/VelodyneScan	Velodyne raw data.
/velodyne_points	sensor_msgs/PointCloud2	Velodyne raw data converted into Point Cloud format.

3.8 Ublox M8U

This data is be logged in binary format (.ubx files) and converted to the following RINEX 3.03 files. The binary files can be processed using the RTKCONV open source tool.

3.9 Argonaut

This data is be logged in binary format (.rok files). As this sensor is included for backup in case Ublox log fails, no conversion has been done.

3.10 Laser Tracker

Collected data from the Laser Tracker reference system at relevant instants is contained in a XLSX file with the following content:

```
Translation in X axis Translation in Y axis Translation in Z axis Rotation  in  X  axis
       Rotation in Y axis    Rotation in Z axis
```

Those relevant instants correspond to the start and end time of the dynamic tests. It is important to note that those instants times were captured from the Laser Tracker laptop, which was not synchronized with the timer used to register the start and end time of the tests. That is why there are slight differences between those times. However, this is not a problem as the only objective of these time values was to find the correspondence between the measurements and the respective test.

4. Navigation sensors data collection

This section contains the codification of the files generated during the static and dynamic tests performed in a tomato greenhouse in Lezama (see RF-02 for description of tests and scenarios). The tests were performed in two different days: 12-02-2018 and 19-02-2018.

Several navigation sensors were logged during the tests. Part of the sensors were logged directly on board by the robot while others were attached to the platform only for the test and recorded by other means such as laptops or SD memories as shown in the following figure:

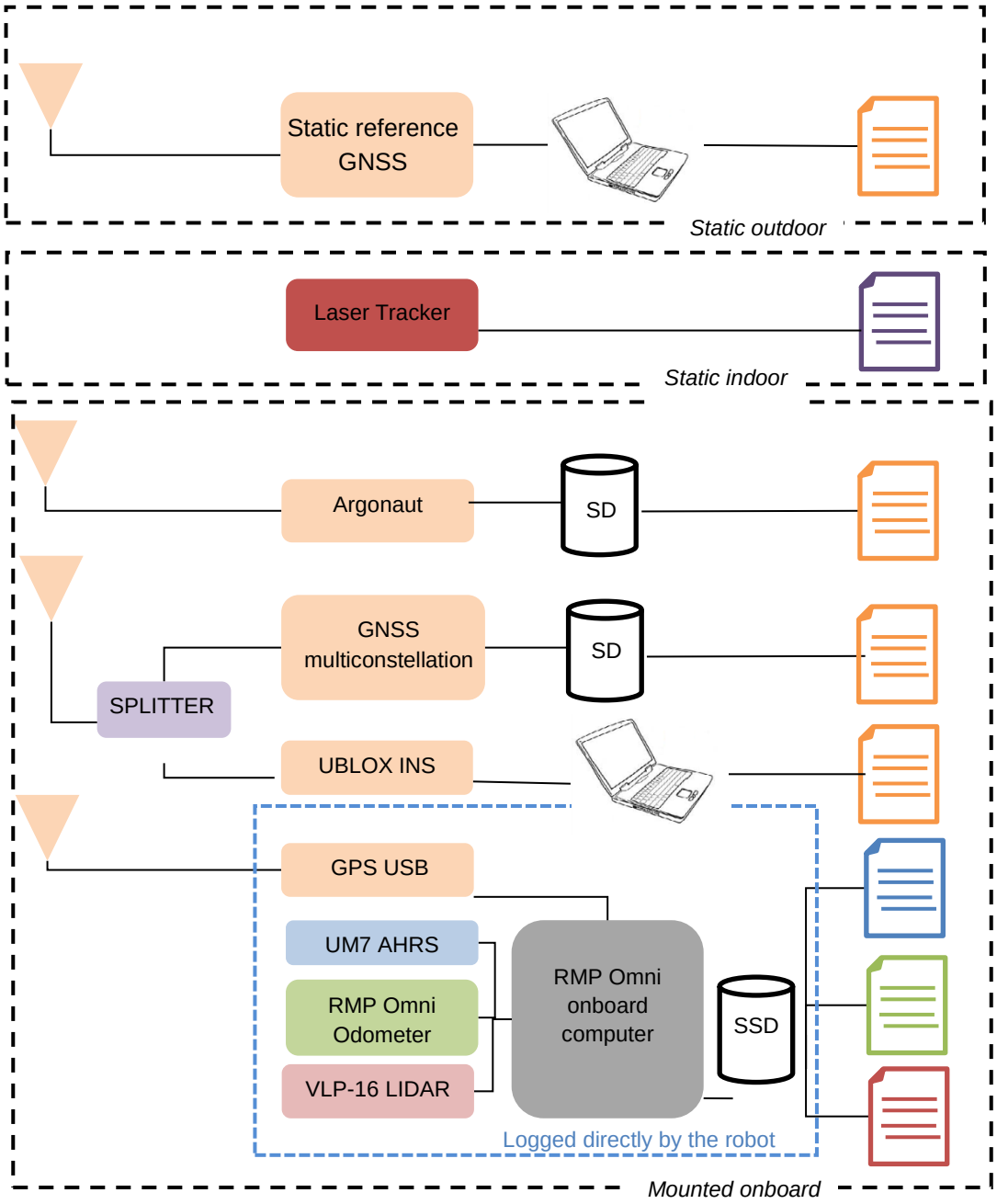

Figure 4.1: Test configuration and sensor disposition

The following sections take inventory of the files generated during navigation tests. Some test has been repeated in order to take into account different conditions (curtains on/off) or repetitions, so a letter may appear in the test name. For each test (and theirs variants) a data collection path relative to the repository structure if given. For each sensor in the test, the involved files are given.

In some cases compressed files in .7z format are used to contain the data collection formats described in section 3. UM7 (IMU) orientation sensor data is split in four files (_data.csv, _mag.csv, _rpy.csv and _temperature.csv) because this is how the robot platform driver gives the data. But each row corresponds to the data acquired at the same timestamp, so it can be merged easily all the data in one file. The LiDAR data are no straightaway available in repository due to its volume.

4.1 Test 1

Date: 12-02-2018	Start Time: 09:32	End Time: 11:37
GNSS multiconstellation	2h static test open sky.7z	

4.2 Test 2A

Date: 12-02-2018	Start Time: 11:51	End Time: 12:24
GNSS multiconstellation	30 min static indoor.7z	

4.3 Test 2B

Date: 12-02-2018	Start Time: 13:00	End Time: 12:59
GNSS multiconstellation	30 min static indoor curtains.7z	

4.4 Test 3

Date: 19-02-2018	Start Time: 12:20	End Time: 12:44
Laser Tracker	Laser_Tracker.xls - Measurement 1 at 12:30 - Measurement 2 at 12:43	
GNSS multiconstellation	Log.sbf.A.7z	
Ublox	Log1.ubx	
Argonaut	20180219_6.rok	
IMU	20180219_113446_gps.csv 20180219_113446_um7_data.csv 20180219_113446_um7_mag.csv 20180219_113446_um7_rpy.csv 20180219_113446_um7_temperature.csv	
Odometry	20180219_113446_gps.csv 20180219_113446_odometry.csv	

4.5 Test 4

Date: 19-02-2018	Start Time: 12:43	End Time: 13:09
Laser Tracker	Laser_Tracker.xls - Measurement 2 at 12:43 - Measurement 3 at 13:09	
GNSS multiconstellation	Log.sbf.A.7z	
Ublox	Log1.ubx	
Argonaut	20180219_6.rok	
IMU	20180219_114742_gps.csv 20180219_114742_um7_data.csv 20180219_114742_um7_mag.csv 20180219_114742_um7_rpy.csv 20180219_114742_um7_temperature.csv	
Odometry	20180219_114742_gps.csv 20180219_114742_odometry.csv	

4.6 Test 5 A

Date: 19-02-2018	Start Time: 13:17	End Time: 13:28
Laser Tracker	Laser_Tracker.xls - Measurement 3 at 13:17 - Measurement 4 at 13:28	
GNSS multiconstellation	Log.sbf.A.7z	
Ublox	Log1.ubx	
Argonaut	20180219_7.rok	
IMU	20180219_121723_gps.csv 20180219_121723_um7_data.csv 20180219_121723_um7_mag.csv 20180219_121723_um7_rpy.csv 20180219_121723_um7_temperature.csv	
Odometry	20180219_121723_gps.csv 20180219_121723_odometry.csv	

4.7 Test 5 B

Date: 19-02-2018	Start Time: 13:35	End Time: 13:51
Laser Tracker	Laser_Tracker.xls - Measurement 5 at 13:35 - Measurement 6 at 13:51	
GNSS multiconstellation	Log.sbf.A.7z	
Ublox	Log1.ubx	
Argonaut	20180219_7.rok	
IMU	20180219_123835_gps.csv 20180219_123835_um7_data.csv 20180219_123835_um7_mag.csv 20180219_123835_um7_rpy.csv 20180219_123835_um7_temperature.csv	
Odometry	20180219_123835_gps.csv 20180219_123835_odometry.csv	

4.8 Test 5 C

Date: 19-02-2018	Start Time: 14:00	End Time: 14:08
Laser Tracker	Laser_Tracker.xls - Measurement 6 at 14:00 - Measurement 7 at 14:07	
GNSS multiconstellation	Log.sbf.A.7z	
Ublox	Log1.ubx	
Argonaut	20180219_7.rok	
IMU	20180219_130001_gps.csv 20180219_130001_um7_data.csv 20180219_130001_um7_mag.csv 20180219_130001_um7_rpy.csv 20180219_130001_um7_temperature.csv	
Odometry	20180219_130001_gps.csv 20180219_130001_odometry.csv	
Static reference GNSS	Nov 19-02-2018 13h57m36s Dynamic Test	

5. Images data collection

Pictures of tomato plants were taken by three types of cameras, which are distinguished in the file name in the format tif. The pictures were taken according to the staff's consideration but always we have the both undersides, and upper sides of the leaves, including the stems. Images were taken with pests, pest-free, and artificial eggs. (See table 5.1 and 5.2).

The scanning area was selected by the worker, then the cameras were manually focused, and adjusted the aperture (optimal and deliberately with minor variations). Between each of the images, we changed the position of the camera to the object being shot (so that each picture was a bit different).

The aim was to obtain different groups of images containing all parts of the plants (leaves, stems, growth peak) where the occurrence of pests will be monitored in order to test the system for automatic image detection of pests in the image.

When using the DataCam 2016 black-and-white camera, we used mainly artificial lighting in the R, G, B, and NIR systems. The images were taken in groups in each channel of 4-8 images of specific places, plant, plants part (for example: in channel R - 4-8 pictures with less camera movement, then in channel G - 4-8 pictures, etc.). The pictures were saved in the PC memory. The aim was to make it possible to compare the visual aspect, contrast of the individual structures in the picture and between individual channels.

When using a color camera, we used either a white LED light with the ability to amplify a blue light or we used a natural light. When using a 3CCD camera, the channels (R, G, B) were separated only after post-processing. In the case of the Lezama greenhouse test, we also tested backlighting.

The name of the individual images was automatically generated based on the sequence described in section 3.1 (camera selection, light type, pests, etc.). Images are stored on a separate computer by date of purchase.

5.1 Lezama Greenhouse Scanning Testing

Date from: 19-02-2018 Date to: 19-02-2018	
Data collection path	WP2\Data Collection\18-02-2018 plants pictures Lezama Mendelu
MII - G1-2000	Settings: exposition time 0.010 seconds (all pictures) aperture - not monitored CCD temperature – 20.5-24.5 °C natural light and artificial illumination (R, G, B, NIR)
	Files and types of images: **Healthy plants**: from 1_1_1_4_1_1_20180212-095430.tif to 1_1_1_4_1_1_20180212-100618.tif 1_1_2_4_2_1_20180212-102220 to 1_1_2_4_2_1_20180212-102338 1_1_2_4_3_1_20180212-101841 to 1_1_2_4_3_1_20180212-101919 1_1_2_4_4_1_20180212-101220 to 1_1_2_4_4_1_20180212-101530 1_1_2_4_5_1_20180212-102750 to 1_1_2_4_5_1_20180212-102841

	The pest infestation (eggs): from 1_1_1_4_1_1_20180212-111402 to 1_1_1_4_1_1_20180212-114204 1_1_1_4_5_1_20180212-112607 1_1_2_4_2_1_20180212-111756 to 1_1_2_4_2_1_20180212-111949 1_1_2_4_3_1_20180212-112900 to 1_1_2_4_3_1_20180212-113153 1_1_2_4_5_1_20180212-112541 to 1_1_2_4_5_1_20180212-112609 **The pest infestation (larvae)**: from 1_1_1_4_1_1_20180212-122544 to 1_1_1_4_1_1_20180212-122615 from 1_1_2_4_2_1_20180212-115541 to 1_1_2_4_2_1_20180212-125119 from 1_1_2_4_3_1_20180212-115317 to 1_1_2_4_3_1_20180212-124146 from 1_1_2_4_4_1_20180212-114645 to 1_1_2_4_4_1_20180212-124733 from 1_1_2_4_5_1_20180212-120115 to 1_1_2_4_5_1_20180212-125455
JAI's AD-130GE	Settings: exposition time - 0.08 s aperture - not monitored natural light only
	Files and types of images: **Healthy plants**: from 1_1_1_2_6_1-20180212-113633 to 1_1_1_2_6_1-20180212-114434 **The pest infestation (eggs)**: from 1_1_1_2_6_1-20180212-120156 to 1_1_1_2_6_1-20180212-120644 **The pest infestation (larvae)**: 1_1_1_2_6_1-20180212-131123 to 1_1_1_2_6_1-20180212-131947

5.2 Cultivation Laboratory Scanning Testing

Date from: 29-12-2017 Date to: 10-04-2018	
Data collection path	WP2\Data Collection\16_01_2018 plants pictures; 05-02-2018; 09-02-2018 plants pictures; 22-02-2018 plants pictures; 26-03-2018 plants pictures
JAI's AD-130GE	Settings: exposition time 0.08 seconds (all pictures)

	aperture - not monitored artificial illumination (white light – LED or fluorescent lamps)
	Files and types of images:
MII - G1-2000	Settings: exposition time 0.030 seconds (all pictures) aperture - not monitored artificial illumination (R, G, B or fluorescent lamps)
	Files and types of images: **File 05-02-2018:** Healthy plants: From 1_2_1_4_1_1_20180202-144023 to 1_2_2_4_2_1_20180202-150306 1_2_2_4_3_1_20180202-145412 from 1_2_2_4_4_1_20180202-150003 to 1_2_2_4_4_1_20180202-150004 from 1_2_2_4_5_1_20180202-150920 to 1_2_2_4_5_1_20180202-150921 Healthy plants with artificial eggs: from 1_2_2_4_2_1_20180202-155036 to 1_2_2_4_2_1_20180202-173612 from 1_2_2_4_3_1_20180202-160151 to 1_2_2_4_3_1_20180202-171606 from 1_2_2_4_4_1_20180202-160424 to 1_2_2_4_4_1_20180202-165808 from 1_2_2_4_5_1_20180202-154704 to 1_2_2_4_5_1_20180202-174749 **File 09-02-2018:** Healthy plants with artificial eggs: from 1_2_2_4_1_1_20180208-151538 to 1_2_2_4_5_1_20180208-160247
Moravian Instruments – DataCam 2016	Settings: exposition time 0.030 seconds (all pictures) aperture - not monitored artificial illumination (R, G, B, NIR)
	Files and types of images: **File 22-02-2018:** Healthy plants: from 1_2_2_5_2_1_20180222-114437 to 1_2_2_5_5_1_20180222-135158 **File 26-03-2018/File 16-03-2018:** Healthy plants: from 1_2_2_5_2_1_20180316-125119 to 1_2_2_5_5_1_20180316-135615 **File 26-03-2018/File 23-03-2018:**

	Healthy plants: from 1_2_2_5_2_1_20180323-143344 to 1_2_2_5_5_1_20180323-144724 The pest infestation (adults): Whitefly from 1_2_2_5_1_1_20180323-133517 to 1_2_2_5_5_1_20180323-135101
JAI's Gev-AP-3200T-PGE	Settings: exposition time 0.080 seconds (all pictures) aperture - not monitored artificial light: (1) direct white light – LED; (2) scattered artificial light (fluorescent lamps)
	Files and types of images: Healthy plants: 1_2_2_6_1_1_20180406-142604 from 1_2_2_6_1_1_20180406-143218 to 1_2_2_6_1_1_20180406-143530 from 1_2_2_6_1_1_20180406-144348 to 1_2_2_6_1_1_20180406-144540 from 1_2_2_6_1_1_20180406-152408 to 1_2_2_6_1_1_20180406-152944 The pest infestation (eggs): from 1_2_2_6_1_1_20180406-132454 to 1_2_2_6_1_1_20180406-133338 from 1_2_2_6_1_1_20180406-142748 to 1_2_2_6_1_1_20180406-142958 from 1_2_2_6_1_1_20180406-143704 to 1_2_2_6_1_1_20180406-144218 from 1_2_2_6_1_1_20180406-144802 to 1_2_2_6_1_1_20180406-144838 The pest infestation (adults): from 1_2_2_6_1_1_20180406-145548 to 1_2_2_6_1_1_20180406-152230 from 1_2_2_6_1_1_20180406-153154 to 1_2_2_6_1_1_20180406-153756

Date from: 13-04-2018 Date to: 13-04-2018	
Data collection path	WP2\Data Collection\18-04-2018 plants pictures
JAI's Gev-AP-3200T-PGE	Settings: exposition time – 0.08 s aperture – not monitored artificial light: (1) direct white light – LED; (2) scattered artificial light (fluorescent lamps)
	Files and types of images: Healthy plants: from 1_2_2_6_1_1_20180413-134240 to 1_2_2_6_1_1_20180413-135346 The pest infestation (eggs): whitefly from 1_2_2_6_1_1_20180413-125112 to 1_2_2_6_1_1_20180413-131208 1_2_2_6_1_1_20180413-131936

	1_2_2_6_1_1_20180413-132026 1_2_2_6_1_1_20180413-132118 from 1_2_2_6_1_1_20180413-132644 to 1_2_2_6_1_1_20180413-133036 The pest infestation (adults): whitefly from 1_2_2_6_1_1_20180413-131314 to 1_2_2_6_1_1_20180413-131516 1_2_2_6_1_1_20180413-132008 from 1_2_2_6_1_1_20180413-132344 to 1_2_2_6_1_1_20180413-132428 from 1_2_2_6_1_1_20180413-133950 to 1_2_2_6_1_1_20180413-134010 The pest infestation (adults and eggs): whitefly from 1_2_2_6_1_1_20180413-133052 to 1_2_2_6_1_1_20180413-133422