



RUSTWATCH



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EXECUTIVE SUMMARY

The Trap Nursery Data Management System (TNDMS) is a data management, analysis and display system for disease observations as well as race phenotyping and genotyping of yellow rust isolates sampled in a set of differential cultivars at Value for Cultivation and Use (VCU) trial sites across Europe. The set is composed of six differentials in 2019 and seven differentials in 2020. The goal is to obtain an early indicator of new YR virulences present in EU VCU trials by phenotyping rust disease in the field. Furthermore, the goal is to identify races and/or genotypes from these differentials and to contribute to a European mapping tool, which indicates the disease pressure of Yellow Rust (YR), Leaf Rust (LR) and Stem Rust (SR) in susceptible cultivars at VCU trial sites.

This report is a documentation of the system developed as well as a user guide for specific tools and services. It refers to Task 4.2 and Deliverable 4.4 in the RustWatch project in interaction with the task 3.2. Thanks are due to all VCU partners and labs that have contributed.



RUSTWATCH
WHEAT RUST EARLY WARNING

Trap Nursery Data Management System (TNDMS)

Documentation and user guide

Aarhus University, Foulum, 22 July 2019

Jens G. Hansen, Poul Lassen and Valérie Cadot

WHEAT RUST TOOLBOX

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TRAP NURSERY MANAGEMENT

Overview Trials Trial sites **Trial site map** Cultivars Export

Map of Europe showing numerous blue dots representing trap nurseries. The map includes a compass and zoom controls. A small text box in the bottom right corner of the map area reads: "GRRC, Aarhus University 2019. Map tiles by Stamen Design, under CC BY 3.0. Data by OpenStreetMap, under ODbL."

Web site provided by Aarhus University, Faculty of Science and Technology, Department of Agroecology.
Report technical problems to webmaster: Poul Lassen. Optimized for screen size 1280x800.
Version 3.6. Build: 7114. Release date: Monday, June 24, 2019.

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1. Introduction

The Trap Nursery Data Management System (TNDMS) is a data management, analysis and display system for disease observations as well as race phenotyping and genotyping of yellow rust isolates sampled in a set of differential cultivars at VCU trial sites across Europe. The set is composed of six differentials in 2019 and seven differentials in 2020 in order to indicate changes or regional patterns of virulence structures.

This activity is a part of the H2020 RustWatch EU project, 2018-2022:

<http://agro.au.dk/forskning/projekter/rustwatch/>

Objective

- Obtain an early indicator of new YR virulences present in EU VCU trials by phenotyping rust disease in the field, in order to get a better interpretation of the resistance performance of cultivars
- Identify races and genotypes in diagnostic labs, by genotyping (SSR markers) or/and pathotyping
- Contribute to a Europe mapping tool indicating the disease pressure from yellow rust, leaf rust and stem rust, by scoring of rust disease in local susceptible cultivars at VCU trial sites.

Output

- A Trap Nursery Data Management, analysis and display system in the Wheat Rust Toolbox, managed by the VCU network in collaboration with RustWatch and the Global Rust Reference Center (GRRC).

Outcome

1. The evaluation of the VCU trials on wheat will be improved, because knowledge on local wheat rust genotypes and phenotypes can be included in the evaluation of results
2. VCU contributes to the RustWatch European early warning system for wheat rust diseases
3. Use of a common database system will strengthen collaboration, stimulate harmonisation of methods and make results more robust.

This report is a documentation of the system developed as well as a user guide for specific tools and services. It refers to Task 4.2 and Deliverable 4.4 in the RustWatch project in interaction with the Task 3.2. Thanks are due to all VCU partners and labs that have contributed.

2. Methods

The data collection is organised in close collaboration with the VCU network in Europe. Seed is prepared by Tystofte Foundaton in Denmark for six differential cultivars and planted out at VCU trial sites across Europe. The differential set is composed of the following wheat cultivars:

Ambition; Spalding Prolific; Rendez-vous; Compair; Moro and Mariboss.

The +/- virulence on Ambition is a resistance component discriminating the Warrior and the Warrior (-) races, Spalding Prolific contains the YrSP resistance gene, Rendez-vous probably Yr17, Compair Yr8 + some unknown resistance gene(s), Moro Yr10 and Mariboss Yr15. Those genes are effective in large regions in Europe, and the patterns of disease attack on the differentials might indicate evolutionary changes in the race structure in a region as well as the appearance of new races.

Thus, the approach is “hunting the new”: send in a sample and find out what it is. If the sample represents something new then alert all relevant stakeholders as a part of the European warning system

2.1 Disease scoring and sampling

Score disease severity on the three upper leaves 2-3 times during the season (heading, flowering and Grain filling)

- 6 RustWatch differentials (only yellow rust). If other diseases, note this in the comment box
- 1 local Yellow Rust (YR) susceptible cultivar
- 1 local Leaf Rust (LR) susceptible cultivar
- 1 local Stem Rust (SR) susceptible cultivar.

Trap nursery partners upload data via a webform in the Wheat Rust Toolbox including a sample code for each sample with a visual score, which is sent to a lab for race identification.

The link between the sample in a VCU trial and the results of race phenotyping and /or genotyping will be the sample code affiliated with a sample sent for race phenotyping at GRRC or another recognised lab.

For sending a sample to the labs, you have to check sample and enter a sample code as a combination of: Country code, YYYY, User initials and sample number, e.g. ES2018ALA102

Local Trap Nursery partners can download own data and see all results from the VCU network on maps and charts.

2.2 RustWatch disease severity scale

RustWatch Disease severity scale

1-9 scale	Disease severity
1	0
2	0,1 (trace)
3	0,5
4	1
5	5
6	10
7	25
8	50
9	>75

RustWatch Disease severity classes on maps

For:

- Disease on differentials
- Disease pressure



The level of 5% severity is used as the midpoint of the scale. In general, this is Max disease accepted by breeders and it is also a threshold for control with fungicides in many countries according to [EuroWheat](#). The same scale is used in the Wheat Rust Surveillance App developed for uploading disease surveillance and monitoring metadata from farmers' fields and experimental sites.

Valérie Cadot manages the list of Trap Nursery partners in the VCU network and she coordinates all activities

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valerie.cadot@geves.fr

2.2 What is The Wheat Rust Toolbox?

[Login to the Wheat Rust Toolbox](#)

The Wheat Rust Toolbox is a data management, analysis and display system for global wheat rust data. It has been developed as a platform in previous projects and its associated outputs and web tools can be found on websites such as:

- RustTracker (<https://rusttracker.cimmyt.org/>)
- GRRRC website (<http://wheatrust.org/>)
- EuroWheat (<http://agro.au.dk/forskning/internationale-platforme/eurowheat/>).

All data that has been quality controlled are publicly available via maps and charts on these information platforms. As part of the RustWatch project, new tools were developed and existing tools improved for the data management within this project. Results from the RustWatch project are then able to be shared across platforms outside of the main project.

A new approach in the data management is that each lab now has its own space in the toolbox. Partners from each lab upload, quality control and manage their own data. Once the data is ready for publication, one person-in-charge per lab moves the data to level 2 in the toolbox where the data will be available for an Expert panel. Once the data has been approved by the expert panel, the data can be moved to the public domain by the task leaders at the GRRRC.

Isolates sampled via the Trap Nursery Data Management System is an integrated part of this and the results from the nurseries are merged with results from national surveys, samples from experimental sites, etc.

Authorized VCU partners can login and have access to different parts of the system.

- Trap nursery partners can upload disease scorings on differential cultivars and reference cultivars susceptible to YR, LR and SR and see uploaded data from all trials on-the-fly on maps and in overview tables. They can edit their own primary data
- The Manager of the system can generate new users with login, new trial sites and new trials. The manager can also download all primary data from all trials in one Excel file.

GRRRC is responsible for the development and improvements of the Wheat Rust Toolbox – in collaboration with many BGRI and RustWatch partners.

3. Generating users, Trial sites and Trials

After login the TNDMS manager has access to the Trap nursery management page that includes six tab pages:

- Overview
- Trials
- Trial sites
- Trial site map
- Cultivars
- Export.

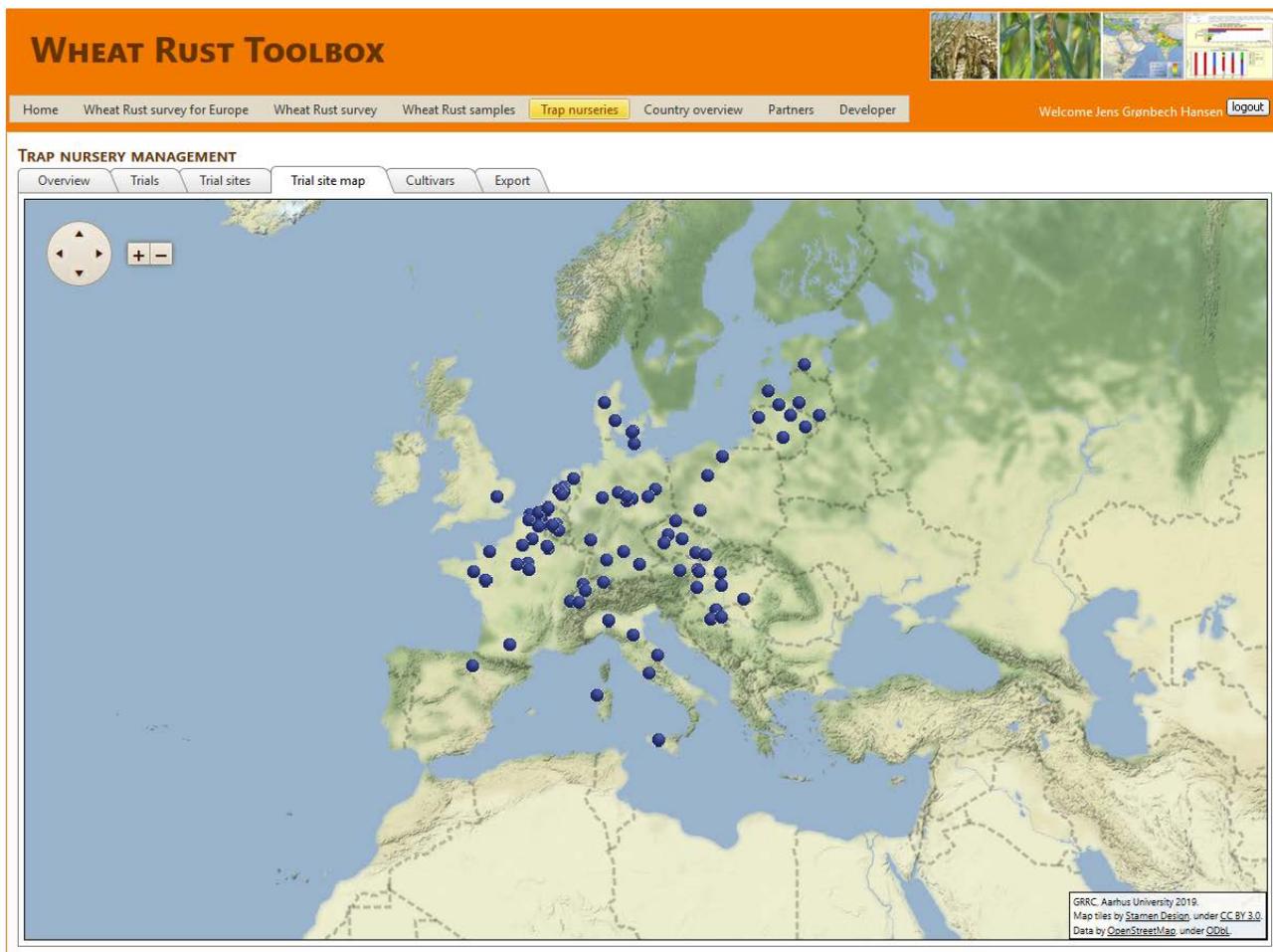


Figure 1. Trap Nursery Management menu

The Overview table indicates which trial sites have reported data and how many times (dates) rust severity was scored in the differentials (Fig.2).

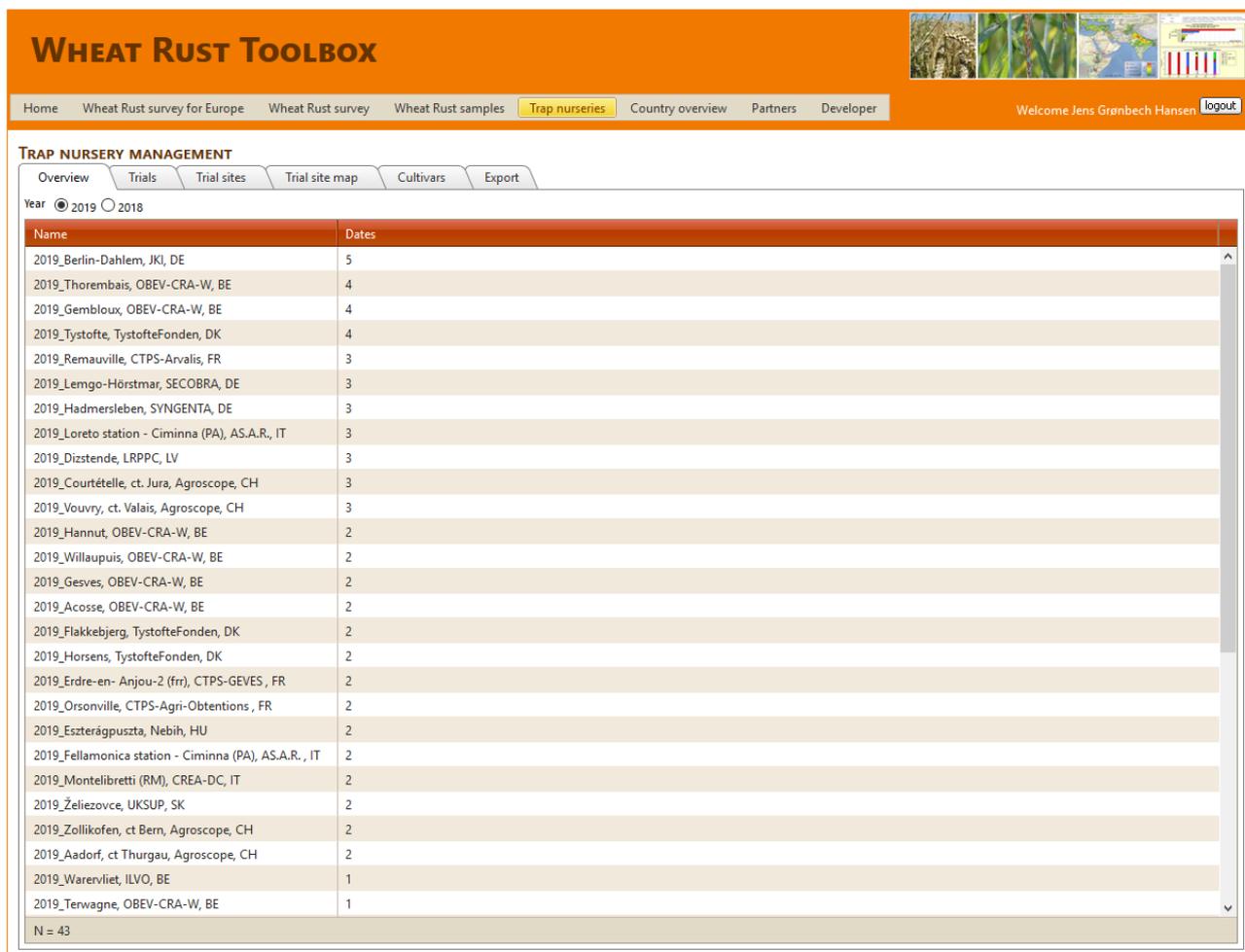


Figure 2. Overview tab: Results from 43 trials out of 83 were uploaded, some with up to five scoring dates.

A trial site is identified by the following variables:

- Country,
- Responsible Institution
- Name (of the area or responsible experimental station / company)
- Geoposition (GPS latitude/longitude in decimal coordinates)
- Altitude

Only the manager of the system can generate a new trial site (Fig. 3)

Even if the exact location of the trials changes (up to 5 km) between years, then use the same Trial site name!

WHEAT RUST TOOLBOX

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[Wheat Rust survey for Europe](#)
[Wheat Rust survey](#)
[Wheat Rust samples](#)
[Trap nurseries](#)
[Country overview](#)
[Partners](#)
[Developer](#)

Welcome Jens Grønbech Hansen [logout](#)

TRAP NURSERY MANAGEMENT

Overview
Trials
Trial sites
Trial site map
Cultivars
Export

Country	Institution	Name	Latitude	Longitude	Altitude	Selected			
Austria	AGES	Fuchsenbigl	48.19492	16.74832		<input checked="" type="checkbox"/>			^
Austria	AGES	Gerhaus	48.05925	16.83895		<input checked="" type="checkbox"/>			
Austria	AGES	Grabeneegg	48.15115	15.25205		<input checked="" type="checkbox"/>			
Belgium	ILVO	Bassevelde	51.16030	3.39050		<input checked="" type="checkbox"/>			
Belgium	ILVO	Leffinge	51.15287	2.90839		<input checked="" type="checkbox"/>			
Belgium	ILVO	Merelbeke	50.97521	3.76322		<input checked="" type="checkbox"/>			
Belgium	ILVO	Poperinge	50.88696	2.78239		<input checked="" type="checkbox"/>			
Belgium	ILVO	Warervliet	51.26471	3.63251		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Acosse	50.59790	5.05268		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Enghien	50.67035	4.08419		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Gembloux	50.61963	4.76010		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Gesves	50.40948	5.10404		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Hannut	50.67669	5.05915		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Ohey	50.39073	5.12526		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Scy	50.30821	5.21698		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Terwagne	50.60668	4.76259		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Thorembais	50.59863	4.68882		<input checked="" type="checkbox"/>			
Belgium	OBEV-CRA-W	Willaupuis	50.56071	3.60417		<input checked="" type="checkbox"/>			
Croatia	CCAFRA/HCPHS	Kutjevo	45.38610	17.81290		<input checked="" type="checkbox"/>			
Croatia	CCAFRA/HCPHS	Osijek	45.52681	18.67751		<input checked="" type="checkbox"/>			

N = 101

Figure 3. Trial site tab. By July 2019, 101 Trial sites were implemented in the toolbox.

Trial names are generated based on a combination of Year, Trial site name, Responsible Institution and Country. Therefore, it is important that all trial sites have these four variables defined.

To generate new trials for a new year the Manager can select any trial site names via a drop down list with checkmarks. Then trials for a news season can be generated automatically by the database (Fig. 4).

The definition and affiliation of cultivars in the Differential set are managed on the Cultivar tab (Fig. 5)

WHEAT RUST TOOLBOX

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TRAP NURSERY MANAGEMENT

Overview Trials Trial sites Trial site map Cultivars Export

Year 2019 2018

Generate trials for a selected year Year for creating 2018 Trial sites for creating All trial sites selected

Trial	Site	Country	Host genus	Host species	User
2019_Fuchsenbigl, AGES, AT	Fuchsenbigl	Austria	Triticum	sp.	JGH
2019_Gerhaus, AGES, AT	Gerhaus	Austria	Triticum	sp.	JGH
2019_Grabenegg, AGES, AT	Grabenegg	Austria	Triticum	sp.	JGH
2019_Acosse, OBEV-CRA-W, BE	Acosse	Belgium	Triticum	sp.	JGH
2019_Gembloux, OBEV-CRA-W, BE	Gembloux	Belgium	Triticum	sp.	VCA
2019_Gesves, OBEV-CRA-W, BE	Gesves	Belgium	Triticum	sp.	JGH
2019_Hannut, OBEV-CRA-W, BE	Hannut	Belgium	Triticum	sp.	JGH
2019_Leffinge, ILVO, BE	Leffinge	Belgium	Triticum	sp.	JGH
2019_Merelbeke, ILVO, BE	Merelbeke	Belgium	Triticum	sp.	JGH
2019_Poperinge, ILVO, BE	Poperinge	Belgium	Triticum	sp.	JGH
2019_Terwagne, OBEV-CRA-W, BE	Terwagne	Belgium	Triticum	sp.	VCA
2019_Thorembois, OBEV-CRA-W, BE	Thorembois	Belgium	Triticum	sp.	JGH
2019_Warevliet, ILVO, BE	Warevliet	Belgium	Triticum	sp.	JGH
2019_Willaupuis, OBEV-CRA-W, BE	Willaupuis	Belgium	Triticum	sp.	JGH
2019_Kutjevo, CCAFR/HCPHS, HR	Kutjevo	Croatia	Triticum	sp.	VCA
2019_Osijek, CCAFR/HCPHS, HR	Osijek	Croatia	Triticum	sp.	JGH
2019_Brno Chrlice, UKZUZ, CZ	Brno Chrlice	Czech Republic	Triticum	sp.	JGH
2019_Cáslav Filipov, UKZUZ, CZ	Cáslav Filipov	Czech Republic	Triticum	sp.	JGH
2019_Chřastava, UKZUZ, CZ	Chřastava	Czech Republic	Triticum	sp.	JGH
2019_Prague - Ruzyně, VURV, CZ	Prague - Ruzyně	Czech Republic	Triticum	sp.	JGH
2019_Uherský Ostroh, UKZUZ, CZ	Uherský Ostroh	Czech Republic	Triticum	sp.	JGH
2019_Vysoká u Přibramě, UKZUZ, CZ	Vysoká u Přibramě	Czech Republic	Triticum	sp.	JGH
2019_Abildgård, TystofteFonden, DK	Abildgård	Denmark	Triticum	sp.	JGH

N = 84

[New trial](#)

Figure 4. Trials overview table indicating trials used in 2019. New trials can be generated individually by selecting the New trial button.

WHEAT RUST TOOLBOX

Home Wheat Rust survey for Europe Wheat Rust survey Wheat Rust samples **Trap nurseries** Country overview Partners Developer Welcome Jens Grønbech Hansen [logout](#)

TRAP NURSERY MANAGEMENT

Overview Trials Trial sites Trial site map Cultivars Export

Cultivar	Sorting	Image	Color	Gene	Origin	Source
Ambition	1		00CCCC			
Spalding Prolific	2		666600			
Compair	3		FF00FF			
Moro	4		FF6666			
Mariboss	5		0066FF			
Rendezvous	6		FF9966			
Nemo	7		CC3333			

N = 7

[New cultivar](#)

Figure 5. Cultivars tab. Management of Differential cultivars in the system – Names, sorting and colours.

Data for all disease scorings can be exported into Excel (Fig. 6) and the user can make the setting for the exported CSV file so that the data opens nicely in separate columns in the users own Excel sheet (Fig 7).

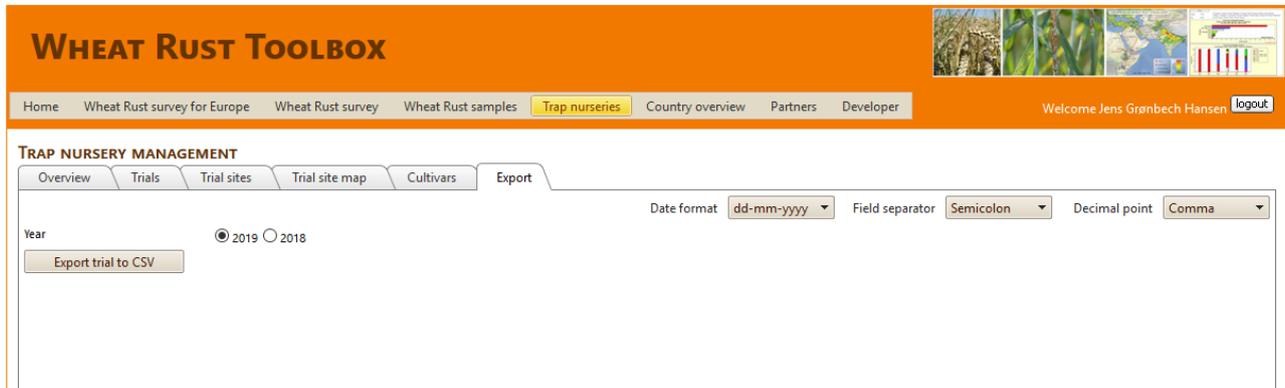


Figure 6. Export tab.

Trial	Date	Replicate	Ambition	Spalding	F	Compar	Moro	Mariboss	Rendezvo	Nemo	YR susceptible	LR susceptible	SR susceptible	YR suscep cultivar [Benchmark]
2019_Acrossse, OBEV-CRA-W, BE	06-05-2019	1	0%	0%	0%	0%	0%	0%	0%	5%	1%	1%	N/A	N/A
2019_Gembeloux, OBEV-CRA-W, BE	06-05-2019	1	0%	0%	0%	0%	0%	0%	0%	25%	5%	0.1%	N/A	5%
2019_Geves, OBEV-CRA-W, BE	06-05-2019	1	0%	0%	0%	0%	0%	0%	0%	10%	10%	0.5%	N/A	5% N/A
2019_Hannut, OBEV-CRA-W, BE	11-05-2019	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50% N/A
2019_Hannut, OBEV-CRA-W, BE	17-05-2019	1	0%	0%	0%	0%	0%	0%	0%	0.5%	>75%	10%	N/A	5% N/A
2019_Hannut, OBEV-CRA-W, BE	23-05-2019	1	0.1%	1%	0%	10%	0%	0%	5%	>75%	N/A	N/A	N/A	N/A
2019_Leffinge, ILVO, BE	06-05-2019	1	0%	0%	0%	0%	0%	0%	0%	1%	0.1%	N/A	N/A	N/A
2019_Poperinge, ILVO, BE	28-05-2019	1	0%	1%	0%	0%	0%	0%	0%	0.1%	25%	N/A	N/A	N/A
2019_Terwagne, OBEV-CRA-W, BE	10-05-2019	1	0%	0%	0%	0%	0%	0%	0%	5%	1%	1%	N/A	N/A
2019_Terwagne, OBEV-CRA-W, BE	04-06-2019	1	0%	10%	0%	10%	0%	0%	0%	50%	N/A	N/A	N/A	N/A
2019_Thorenbat, OBEV-CRA-W, BE	23-05-2019	1	0%	0%	0%	0%	0%	0%	0%	0.3%	1%	0%	N/A	N/A
2019_Willaupts, OBEV-CRA-W, BE	06-05-2019	1	0%	0%	0%	0%	0%	0%	0%	1%	0%	0.5%	N/A	N/A
2019_Willaupts, OBEV-CRA-W, BE	17-05-2019	1	1%	0%	0%	0.3%	0%	0%	0%	10%	5%	N/A	N/A	5%
2019_Willaupts, OBEV-CRA-W, BE	27-05-2019	1	0.5%	0.5%	0%	1%	0%	1%	0%	1%	50%	N/A	N/A	N/A
2019_Willaupts, OBEV-CRA-W, BE	31-05-2019	1	5%	0.5%	0%	5%	0%	5%	0%	1%	50%	N/A	N/A	10%
2019_Warenhiet, ILVO, BE	23-05-2019	1	0%	0%	0%	0%	0%	0%	0%	1%	N/A	N/A	N/A	N/A
2019_Abildgård, Tystoftefonden, DK	03-06-2019	1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	N/A	N/A

Figure 7. Disease scorings for all diff set at VCU trial sites.

The data is uniform for differential set results, but each partner hosting a differential set can decide whether and how many local reference cultivars to add as indicators of the disease pressure of YR, LR and SR on that location. The names of the reference cultivars may differ between regions and countries.

On the submenu Trap nurseries/ User management the manager controls and Edits the list of users. The manager can make a new user – select the button New user. A list with all users including e-mails can be exported to Excel – Select the button Export to CSV.

Init	Alternative ID	Firstname	Lastname	Institution	Department	Country	E-mail	Active
JAU		Jérôme	Auzanneau	AGRI- OBTENTIONS		France	jerome.auzanneau@agri-ob	<input checked="" type="checkbox"/>
BBA		Biruta	Bankina	Latvia University of Agricult		Latvia	biruta.bankina@llu.lv	<input checked="" type="checkbox"/>
SBA		Solene	Barraïs	GEVES		France	solene.barraïs@geves.fr	<input checked="" type="checkbox"/>
CBR		Caroline	Breidenbach			Germany	caroline.breidenbach@juliu	<input checked="" type="checkbox"/>
KBU		Katarina	Buckova	UKSUP Sk.		Slovakia	Katarina.Buckova@uksup.sk	<input checked="" type="checkbox"/>
VCA		Valérie	Cadot	GEVES		France	valerie.cadot@geves.fr	<input checked="" type="checkbox"/>
BCL		Bill	Clark	NIAB		United Kingdom	bill.clark@niab.com	<input checked="" type="checkbox"/>
HCO		Hilmar	Coester	RAGT 2N		Germany	HCoester@ragt.fr	<input checked="" type="checkbox"/>
GDE		Gerhard	Deneken	Tystofte Foundation		Denmark	gde@tystofte.dk	<input checked="" type="checkbox"/>
VDU		Veronika	Dumalasova	VURV		Czech Republic	dumalasova@vurv.cz	<input checked="" type="checkbox"/>
LFE		Liga	Feodorova-Fedotova	Latvia University of Agricult		Latvia	liga.f.fedotova@laapc.lv	<input checked="" type="checkbox"/>
KFL		Kerstin	Flath	JKI		Germany	Kerstin.Flath@julius-kuehn	<input checked="" type="checkbox"/>
AGI		Anna	Giulini	CREA-DC		Italy	annapiamaria.giulini@crea	<input checked="" type="checkbox"/>
JGO		Jérôme	Gorichon	Arvalis institut du Végétal		France	J.GORICHON@arvalisinstitu	<input checked="" type="checkbox"/>
HGO		Henriette	Goyeau	INRA		France	henriette.goyeau@inra.fr	<input checked="" type="checkbox"/>
PGY		Piroska	Gyócsi	NEBIH	Variety testing Department f	Hungary	czibulyasp@nebih.gov.hu	<input checked="" type="checkbox"/>
JGH	jensg.hansen@ag	Jens Grønbech	Hansen	Aarhus University	Department of Agroecology	Denmark	JensG.Hansen@agro.au.dk	<input checked="" type="checkbox"/>
AHA		Alena	Hanzalova	VURV		Czech Republic	hanzalova@vurv.cz	<input checked="" type="checkbox"/>
EHE		Emmanuel	Heumez	INRA MONS		France	emmanuel.heumez@inra.fr	<input checked="" type="checkbox"/>
SHO		Sarah	Holdgate	NIAB		United Kingdom	Sarah.Holdgate@niab.com	<input checked="" type="checkbox"/>

N = 57

New user

Export to CSV Field separator Semicolon User file

Figure 8. Overview of users in the system. Currently 57 people are partners that can upload data.

4. Input of disease severity data and sample code

When a user logs into the toolbox, the system will know i) if this user is affiliated with the Trap Nursery system and 2) which country the user comes from. Only trials from this country are then made available in the drop down list of trials to select from.

First time:

- Select your trial name in the drop down list. This list will only contain trial names from the country you are affiliated with.
- Enter the name for a local YR susceptible cultivar to be used for indication of the local disease pressure.
- Similar for a LR susceptible cultivar.
- Similar for a SR susceptible cultivar.

Steps entering disease observations:

- Select number of replicates in your trial
- Click New date
- Select disease level from drop down. If no disease then select zero (0) in the list. N/A will not be shown
- If samples were taken for genotyping and /or race analysis then checkmark Sample for the cultivar that the sample was taken from
- Select the button samples and enter the sample code for each sample taken
- Select the comment button and enter information if any other diseases dominated in the Diff cultivars or any other relevant information
- Select the button Save to save all entered information!!

As an example, at Flakkebjerg (Fig. 9), a set of the six differential cultivars was planted (Nemo not included). The cultivars Anja and Substance were selected as YR reference cultivars and the cultivar MS brunrust as the LR reference cultivar. In Denmark a SR reference cultivar is not used as SR usually is not present in commercial fields. YR was found on Ambition and Spalding Prolific at trace level. YR was found at 10% severity on Anja and 25% on Substance. LR was scored as 0,1% on 27 June, 2019.

WHEAT RUST TOOLBOX

Home Wheat Rust survey for Europe Wheat Rust survey Wheat Rust samples **Trap nurseries** Country overview Partners Developer
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TRIAL INPUT

Observations

Year 2019 2018

Trial Replicates Observation date

DISEASE SEVERITY IN DIFFERENTIALS

Cultivar	Color	Disease	Sorting	24. May, Rep. 1	Sample	27. Jun, Rep. 1	Sample
Ambition	●	Yellow Rust	1	0%	<input type="checkbox"/>	0.1%	<input type="checkbox"/>
Spalding Prolific	●	Yellow Rust	2	0%	<input type="checkbox"/>	0.1%	<input type="checkbox"/>
Compair	●	Yellow Rust	3	0%	<input type="checkbox"/>	0%	<input type="checkbox"/>
Moro	●	Yellow Rust	4	0%	<input type="checkbox"/>	0%	<input type="checkbox"/>
Mariboss	●	Yellow Rust	5	0%	<input type="checkbox"/>	0%	<input type="checkbox"/>
Rendezvous	●	Yellow Rust	6	0%	<input type="checkbox"/>	0%	<input type="checkbox"/>
Nemo	●	Yellow Rust	7	N/A	<input type="checkbox"/>	N/A	<input type="checkbox"/>

DISEASE SEVERITY IN LOCAL CULTIVARS

	Local cultivar	Color	Disease	Sorting	24. May, Rep. 1	Sample	27. Jun, Rep. 1	Sample
YR susceptible cultivar	<input type="text" value="Anja"/>	●	Yellow Rust	1	0.1%	<input type="checkbox"/>	10%	<input type="checkbox"/>
LR susceptible cultivar	<input type="text" value="MS brunrust"/>	●	Leaf Rust	2	0%	<input type="checkbox"/>	0.1%	<input type="checkbox"/>
SR susceptible cultivar	<input type="text"/>	●	Stem Rust	3	N/A	<input type="checkbox"/>	N/A	<input type="checkbox"/>
YR susceptible cultivar	<input type="text" value="Substance"/>	●	Yellow Rust	4	0.5%	<input type="checkbox"/>	25%	<input type="checkbox"/>

Figure 9. Data uploaded from Flakkebjerg, 2019.

5. Visualisation of Results

On the Trap nurseries / Trap nursery output submenu is the Trial output page with three tabs:

- Severity map
- Severity table
- Trial site map.

These tabs are available for all trap nursery users after login; for instance, the severity map (Fig. 10).

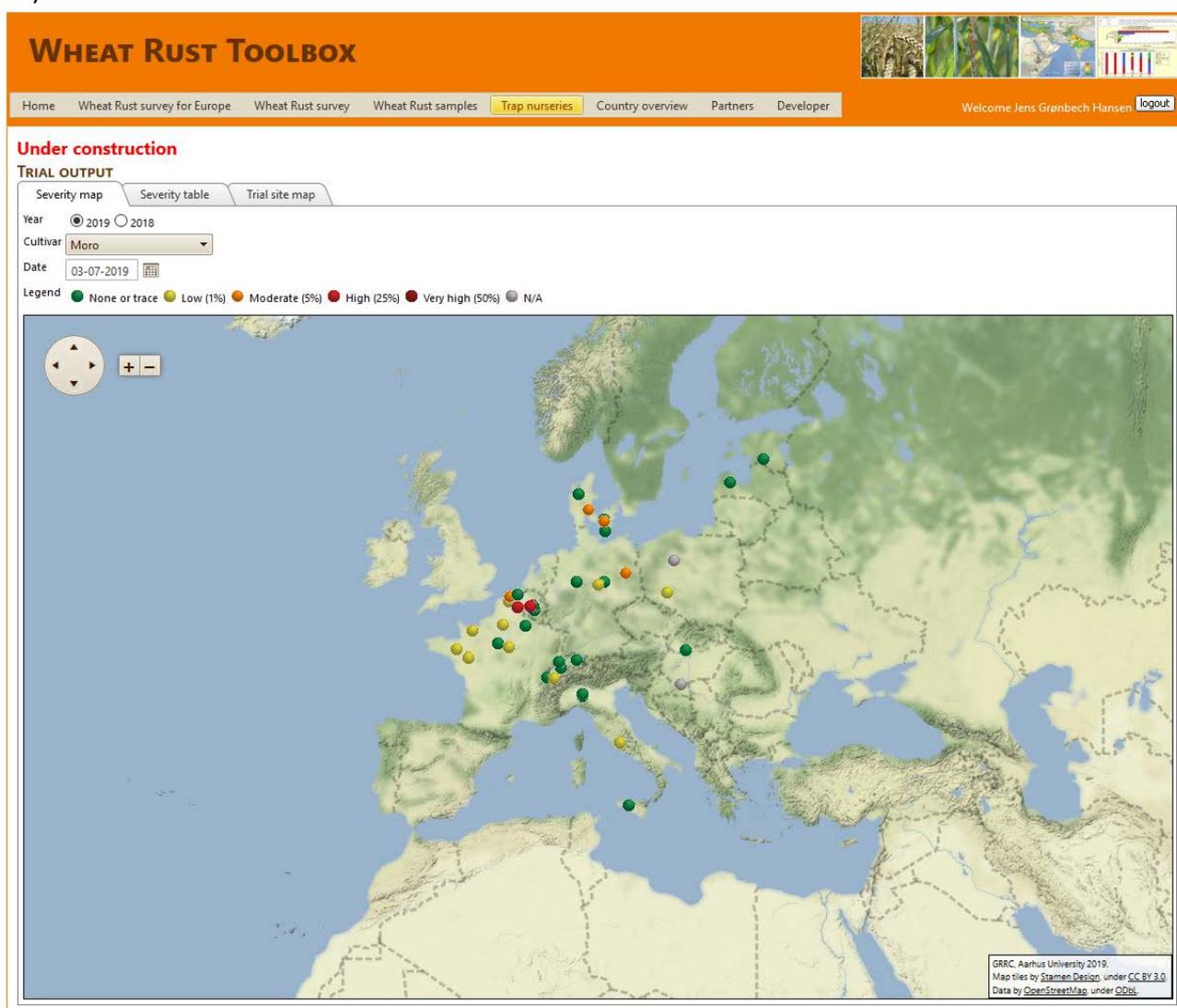


Figure 10. Severity map. Selected the year 2019, Cultivar Moro and the date 3 July. The map shows the disease level on the cultivar Moro at the date close to 3 July.

How to do:

1. Select year
2. Select the cultivar for which you want to display data
3. Select a date (dates are typically in May or June).

You can select one of the six differentials, but additionally:

- Yellow Rust susceptible cultivar
- Leaf Rust susceptible cultivar
- Stem Rust susceptible cultivar.

Each local host selected one or more local susceptible reference cultivars to indicate the local disease pressure for YR, LR and SR. Thus, the data points will indicate disease on a local cultivar, but the cultivars will be different between locations across Europe.

In 2019, several partners uploaded data for more than one reference cultivar per disease. In this first version, the system will show the maximum disease severity score by disease. The best way to indicate the disease pressure on susceptible cultivars remains to be discussed among partners. After feedback on this issue, the system will be adapted accordingly.

On the Severity table tab, results on all differential and reference cultivars by trial can be sorted by country and by up to three differentials. The colours indicate the maximum disease level of YR on differentials (first seven cultivars from the left), and SR on one or more SR susceptible cultivars, LR on one or more LR susceptible cultivars and YR on one or more YR susceptible cultivars (Fig. 11).

A future improvement could consist in classifying disease patterns on differentials into disease reaction profiles allowing quick indication of new yellow rust variants.

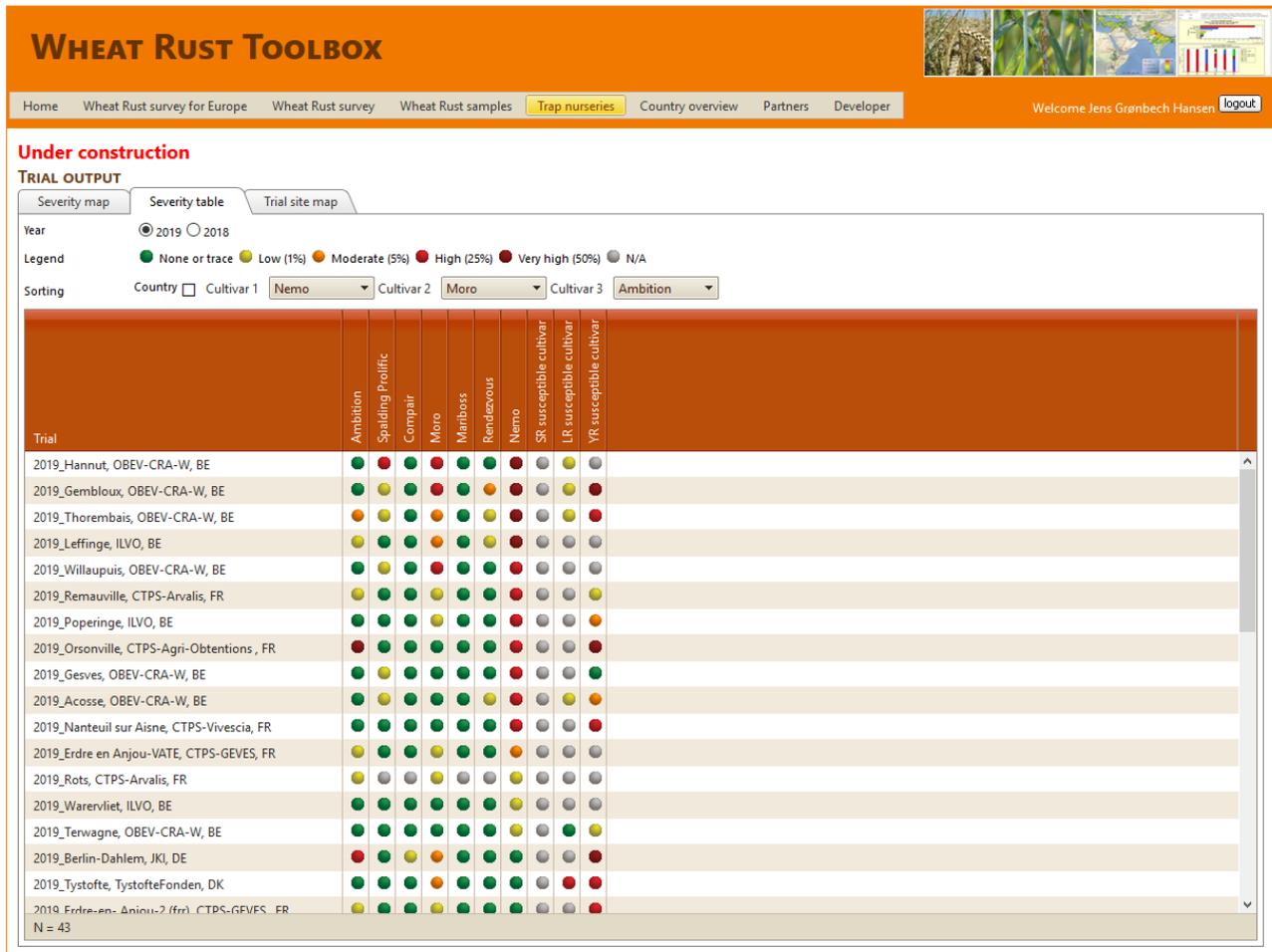


Figure 11. Severity table. Results on all differentials and reference cultivars by trial can be multiple sorted by country and up to three of the differentials.

6. Link between disease observation at VCU trial sites and genotype and race results

In January 2020 AU will implement the system that links the sample codes from the VCU trap nursery system with the genotype and race results in the Samples tables of the database. The implications will be, that the genotype and race results can be filtered and shown on maps and in tables for each VCU trial. The combined data will feed into the Task 4.4, development of Risk management tool for wheat rust diseases in Europe. Guideline and first results were presented by V. Cadot at the EU VCU meeting 26th June 2019 in the Netherlands.

7. Appendix - Database documentation

DATABASE DOCUMENTATION

Rust trials

TRIAL				
Field	Type	Size	Obligatory	Options
TrialAppID	Integer		Yes	-9: N/A 1: Trap Nursery 2: Skimmelstyring 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
TrialID	Integer		Yes	
TrialName	String	100		
PublishedLevel	Integer			0: Unpubl. 1: Country 2: Project 3: Expert 4: Supplier 9: All
PublishedAllDate	Date			
PublishedAllUserInit	String	3		
TrialDescription	String	1073741823		
TrialSiteID	Integer			
HostGenusID	Integer			
HostSpeciesID	Integer			
HostFormalID	Integer			
HostCultivarName	String	50		
UserInit	String	3		
TrialYear	Integer			
Replicate	Integer			
ReferenceTreatmentID	Integer			
DifferentialSetID	Integer			
ColorStr	String	10		
Color	Integer			
MapPositionX	Integer			
MapPositionY	Integer			
Published	Boolean			True False
ModelFirstDateID	Integer			
ModelLastDateID	Integer			

TRIAL SITE				
Field	Type	Size	Obligatory	Options
TrialSiteID	Integer		Yes	
TrialSiteName	String	50		
InstitutionName	String	100		
TrialAppID	Integer			-9: N/A 1: Trap Nursery 2: Skimmelstyring 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
CountryID	String	2		
RegionID	Integer			
Latitude	Decimal			
Longitude	Decimal			
Altitude	Decimal			
MapPositionX	Integer			
MapPositionY	Integer			
Selected	Boolean			True False

TRIAL DATE				
Field	Type	Size	Obligatory	Options
TrialAppID	Integer		Yes	-9: N/A 1: Trap Nursery 2: Skimmelstyring 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
TrialID	Integer		Yes	
TrialDateID	Integer		Yes	
ObservationDate	Date			
Comment	String	1073741823		

CULTIVAR

Field	Type	Size	Obligatory	Options
CultivarID	Integer		Yes	
CultivarName	String	50		
TrialAppID	Integer			-9: N/A 1: Trap Nursery 2: Skimmelstying 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
PathogenGenusID	Integer			
PathogenSpeciesID	Integer			
CultivarTypeID	Integer			1: Differential 2: Mega 3: Local 4: Check cultivar
Gene	String	25		
GeneList	String	50		
Origin	String	100		
Source	String	50		
ColorID	Integer			
SortOrder	Integer			

CULTIVAR OBSERVATION

Field	Type	Size	Obligatory	Options
TrialAppID	Integer		Yes	-9: N/A 1: Trap Nursery 2: Skimmelstying 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
TrialID	Integer		Yes	
TrialDateID	Integer		Yes	
CultivarID	Integer		Yes	
ReplicateID	Integer		Yes	
DiseaseID	Integer		Yes	1: Stem Rust 2: Leaf Rust 3: Yellow Rust
SeverityPercentID	Integer			
SampleCollected	Boolean		Yes	True False
SampleCode	String	100		
SampleTypeID	Integer			
CollectorName	String	100		
InstitutionName	String	100		
GrowthStageID	Integer			

LOCAL CULTIVAR

Field	Type	Size	Obligatory	Options
TrialAppID	Integer		Yes	-9: N/A 1: Trap Nursery 2: Skimmelstying 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
TrialID	Integer		Yes	
LocalCultivarID	Integer		Yes	
LocalCultivarName	String	50		
StandardCultivarID	Integer			
ColorID	Integer			
DiseaseID	Integer		Yes	1: Stem Rust 2: Leaf Rust 3: Yellow Rust
SortOrder	Integer			

LOCAL CULTIVAR OBSERVATION

Field	Type	Size	Obligatory	Options
TrialAppID	Integer		Yes	-9: N/A 1: Trap Nursery 2: Skimmelstying 3: EuroWheat 4: EucaBlight 5: IPM Blight 2.0 6: Wheat Rust Toolbox
TrialID	Integer		Yes	
TrialDateID	Integer		Yes	
LocalCultivarID	Integer		Yes	
ReplicateID	Integer		Yes	
DiseaseID	Integer		Yes	1: Stem Rust 2: Leaf Rust 3: Yellow Rust
SeverityPercentID	Integer			
SampleCollected	Boolean		Yes	True False
SampleCode	String	100		
SampleTypeID	Integer			
CollectorName	String	100		
InstitutionName	String	100		
GrowthStageID	Integer			