RUSTWATCH : European rust surveillance supported by rust trap nurseries in wheat VCU trials

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Context & Aim

Three rust diseases have a strong impact worldwide **on yield losses** in soft wheat: **Yellow Rust (*Puccinia striiformis),* Stem Rust (*Puccinia graminis tritici)*, Leaf Rust (*Puccinia triticina).*** Due to yellow rust, worldwide annual losses are over US$979 million and rust virulence has increased since the appearance of the Warrior races in 2011. H2020 RustWatch is a European project on **wheat rust early warning, based on a multi-stakeholders and multi-network approach,** such as the **Value for Cultivation and Use (VCU)** registration network at European level, and the sharing of communication and research infrastructures.

This project **led by the University of Aarhus in Denmark, from 2018-2022**, involves 24 partners including universities/research institutes, examination offices, agricultural advisory services, and breeders. The aims of **RustWatch are to:**

- **contribute to rust surveys in many countries without national rust diagnostic labs,**
- **intensify and diversify rust sampling by utilizing existing stakeholder networks** within plant breeding, **EU-VCU networks** and agricultural advisory services.

GEVES, the French examination office for registration in the National list, is particularly involved in this project, as **task leader of EU-VCU trap nurseries.**

Outputs

VCU trials contributes generating information on:

1. **New virulences/races for the 3 rusts** by:
   - Visual assessment of **yellow rust severity on the differentials**
   - Sending samples to labs for **identifying genetic groups (SSR analyses) or pathotyping races**
2. **Disease pressure for the 3 rusts in UE mapping tool** by:
   - Visual assessment of disease severity on **susceptible cultivars for the 3 rusts: SR: Stem Rust, LR: Leaf Rust, YR: Yellow Rust.**

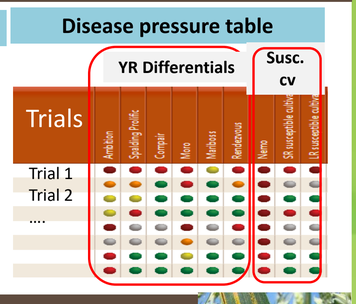
Rust severity scale

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

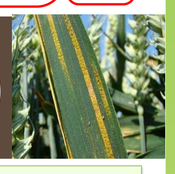
- Disease on differentials
- Disease pressure

None or trace | Low, 1 | Medium, 5 | High, 25 | Very high, 50

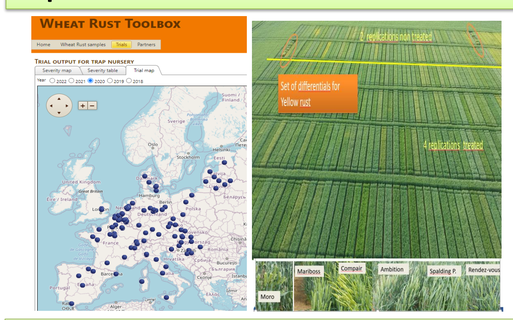
Disease pressure table



Yellow rust: New races from Warrior (-)



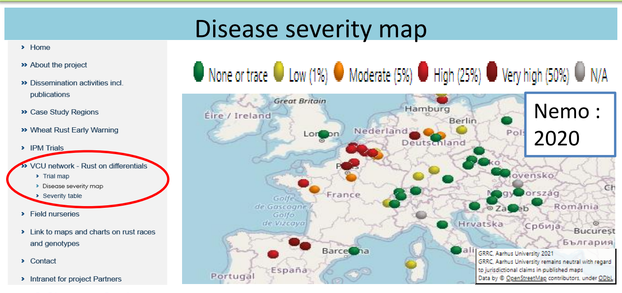
Implantation of 9 YR differential set in 80 to 100 VCU trials accross 18 EU countries



N°	UE Yellow Rust Differentials	Pst S R genes	Pst S7 Warrior	PstS10 Warrior -	PstS10 Nemo/Kalmar	PstS10 Benchmark	PstS10 Amboise	Pst S8 Kranich	PstS13 Triticale 2015
1	Ambition	?	V	A	A	A	A	V	A
2	Spalding Prolific	SP	(V)	V	V	V	V	A	A
3	Compair	8 +	A	A	A	A	A	(V)	V
5	Moro	10	A	A	A	A	A	A	A
5	Mariboss	15	A	A	A	A	A	A	A
6	Rendez-vous	17	V	V	A	V	V	A	A
7	Nemo/Kalmar	?	A	A	V	A	V	A	A
8	Benchmark	?	A	A	A	V	V	A	A
9	Amboise	?	A	A	A	_	V	A	A

Disease severity in VCU trials & other trap nurseries

Disease severity map



3 new YR differentials were added to the YR set:
- Nemo in 2019-20
- Amboise & Benchmark in 2021-22

- Nemo was heavily attacked in FR, BE and SP by Amboise & Benchmark races.
- Mariboss cv, with Yr 15 resistance, is generally not defeated.

Data providers: VCU offices, V. Cadot

Public Website: https://agro.au.dk/forskning/projekter/rustwatch/vcu-network-rust-on-differentials/trial-map/

Mapping of surveillance data on all sites (included VCU trials) on public Website

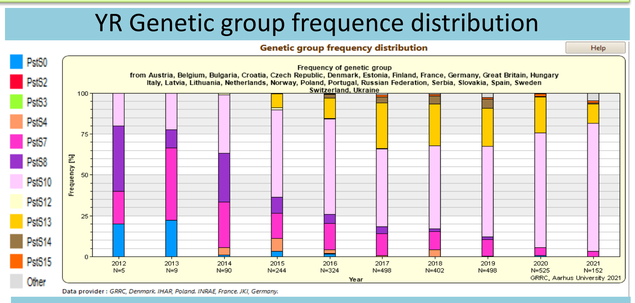
Information present in the Wheat rust toolbox and also on Public Website for YR, but also for SR & LR: http://agro.au.dk/forskning/internationale-platforme/wheatrust/yellow-rust-tools-maps-and-charts/

Genetic groups in EU:

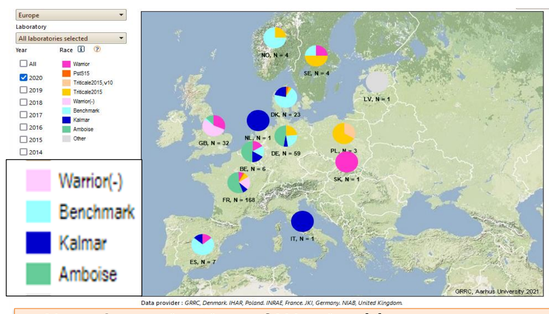
-↑PstS10: prevalent : Warrior (–) races

-↓PstS7 : Warrior race

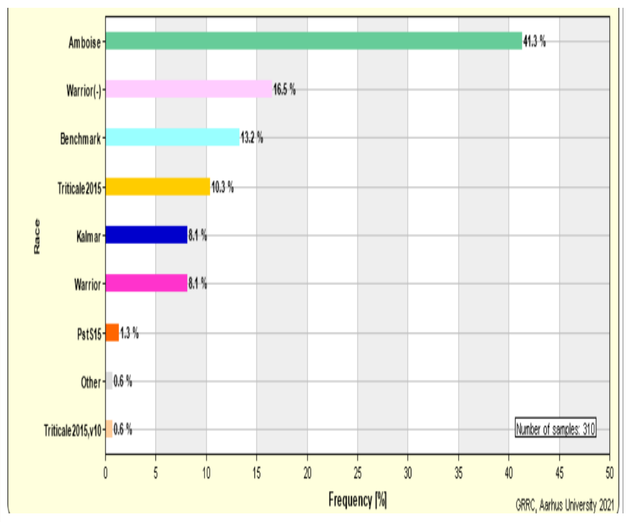
YR Genetic group frequence distribution



YR race frequence map in EU in 2020



YR race frequence in EU in 2020



- **New denomination of Warrior (-) race :**

In 2020, Warrior (–) race, belonging to PstS10 genetic group, split in 4 races :

1. Warrior – : *V. 17/ A. Nemo*
2. Nemo/Kalmar: *A. 17/V. Nemo*
3. Benchmark : *V. 17/A. Nemo*
4. Amboise : *V. 17/ V. Nemo/ V. Amboise*

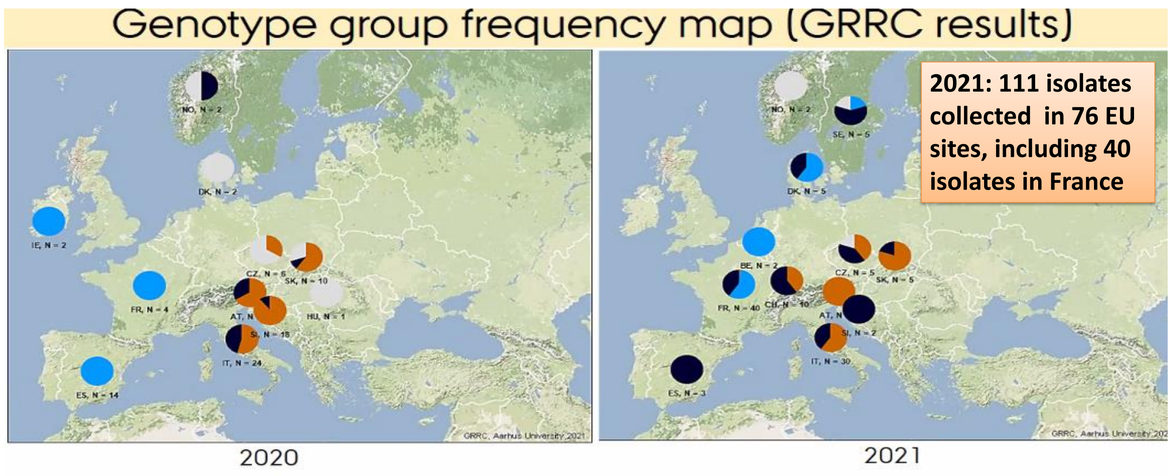
V. = virulent/A.= Avirulent

The 4 newly-named races in 2020 were detected or confirmed in VCU trials.

Prevalence of the new named Amboise race in EU, especially in FR, BE & DE

Stem rust: Spreading in Western Europe

Genotype group frequency map (GRRC results)



2021: 111 isolates collected in 76 EU sites, including 40 isolates in France

2020 2021

Virulence corresponding to NA differentials 1-20 (main R-gene indicated)

	SR Genes																		
Race-Name	5	21	9e	7b	11	6	8a	9g	36	9b	30	17	9a	9d	10	Tmp	24	31	38	McN
TTRTF	5	21	9e	7b	11	6	8a	9g	36	9b	-	17	9a	9d	10	Tmp	-	-	38	McN
TKTTF	5	21	9e	7b	-	6	8a	9g	36	9b	30	17	9a	9d	10	Tmp	-	-	38	McN
TKKTF	5	21	9e	7b	-	6	8a	9g	-	9b	30	17	9a	9d	10	Tmp	-	-	38	McN

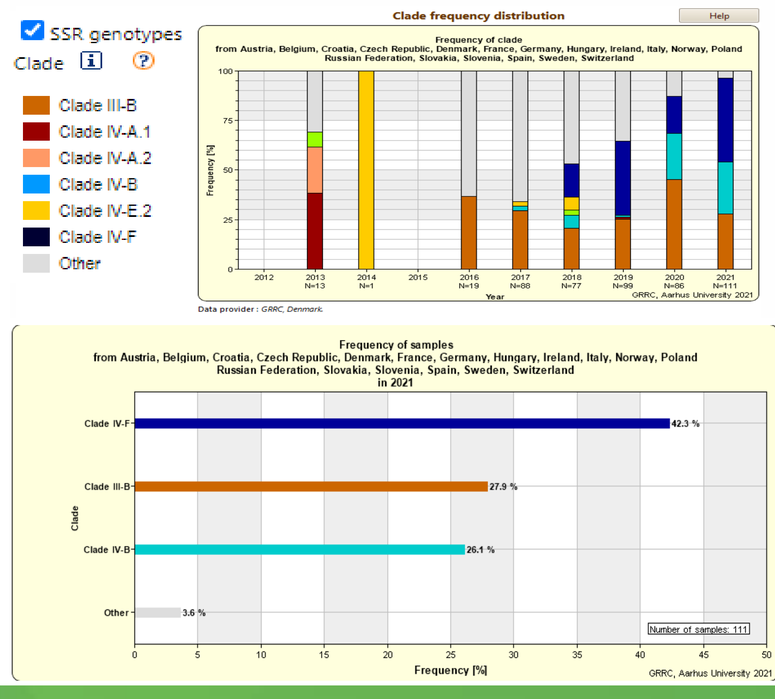
Clade III-B
Clade IV-B
Clade IV-F
Other (multiple)

- **Clade III-B group (race TTRTF):** widespread in Sicily since 2016, has now been detected in several countries in Eastern Europe

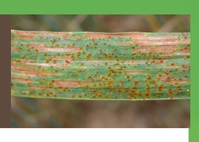
- **Clade IV-F (race TKKTF):** prevalent genetic group in 2021, detected throughout the EU, and previously in Egypt, Iran and Tunisia

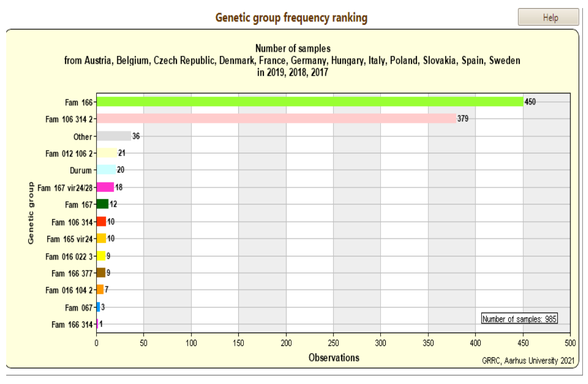
- **Clade IV-B group (races TKTTF and TTTTF):** rather localized in the West and North of the EU **Prevalent in France in 2021**

Clade year distribution chart

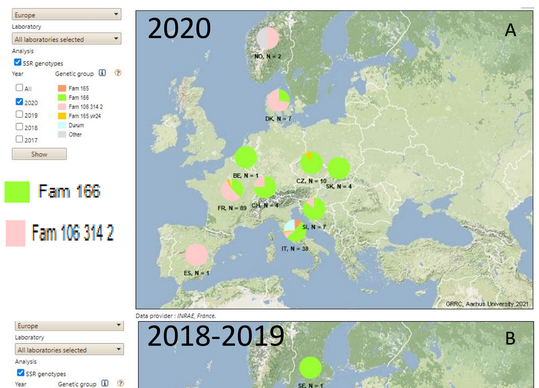


Leaf rust: 2 genetic groups prevalent in EU





Source : H. Goyeau & Kevin Meyer (INRAE,FR)



2 prevalent groups :

1. **Fam 166 :** combines 12 virulences against the 23 Lr genes included in the differential set
2. **Fam 106 314 2**

Source : H. Goyeau & Kevin Meyer (INRAE,FR)

Public Website: https://agro.au.dk/forskning/internationale-platforme/wheatrust/leaf-rust-tools-maps-and-charts/genetic-groups-frequency-map

Field resistance assessment of wheat cv to the 3 rusts

- **YR and LR** : high level of cv resistance in Europe
- **Stem Rust**:
  - Only 15 % less susceptible EU varieties
  - Warming climate can be a risk of increasing stem rust in Europe
  - Breeding for resistance to stem rust can be a new target in Western Europe

Source : Kerstin Flath (JKI)

Which long-term sustainability for this early-warning system?

Different scenarios are discussed for the long-term sustainability of a new European early-warning system for wheat rust diseases, accross questionnaires.

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