

# **Trap Nursery Data Management System**

Hansen JG, Lassen P, Nazari K & Hodson D

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Photo: Kumarse Nazari

# Jens G. Hansen, Poul Lassen, Kumarse Nazari & David Hodson

7 January, 2014

DRRW Activity 23.a, Global Cereal Rust Monitoring System (GCRMS), sub-task: "Development of a web based trap nursery data management and display system"

USER GUIDE





Photo: Mogens Hovmøller & Jens G. Hansen (AU, Agro)

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## Summary

The objective of this report is to document what have been carried out in the DRRW Activity 23.a, Global Cereal Rust Monitoring System (GCRMS), sub-task: "Development of a web based trap nursery data management and display system". The draft system described is aimed to handle results from wheat stem rust Trap Nurseries in Central and West Asia and Africa in 2012 and 2013, organized by ICARDA. The core database and web system is based on the Wheat Rust Toolbox hosted by GRRC at Aarhus University. Basic DB tables hold the basic resistance information on differential -, mega - and local cultivars. A web based management system controls Trial locations, Trial sites and related distribution sets by year and country. Partners can upload own results after login at the Wheat Rust Toolbox, and trial data becomes public after quality control by a group of TN managers and experts. Results are displayed in a set of interactive web based maps and tables analysing which known resistance genes and unknown genes in local cultivars that are still effective under variable growing and climate conditions. New cultivars and breeding genotypes from the DRRW project and other sources are included to monitor the stability of new resistances across years and countries in the region. When unexpected attacks are found, infected leaf and stem material is sent to the GRRC and similar labs for immediate pathogen characterization. This information will be disseminated to all relevant partners via wheat rust early warning systems at GRRC (www.wheatrust.org), ICARDA (www.icarda.org) and CIMMYT (rusttracker.cimmyt.org). The database driven management system, the quality control of data, user friendly analysing tools and immediate dissemination to target audiences will hopefully stimulate to a higher return rate and extended utilization of data from the trap nurseries.

# Background

Use of rust trap nurseries has traditionally been used for "hunting the new" and for the assessment of the pathogenic variation in regions where there was no laboratory facilities and expertise. It has provided valuable information on field responses of adult plant resistance (APR) genes across locations with different growing and climate conditions. Several new breeding genotypes and cultivars with new resistance resources have been released during the DRRW project period. There is a need to include this material in the international trap nurseries to monitor the stability of resistance in this new material in time and across countries. Historically, ICARDA has organized the international Wheat Rust Trap Nurseries in Central and West Asia and Africa. For many reasons the return rate has been low as well as the dissemination and exploitation of results. Therefore, it was decided to develop a web based Trap Nursery Management System aiming to 1) manage and control information on trial sites, trials, differentials used and distribution sets 2) store, quality control and analyse the results obtained from the trials 3) display the results and integrate this information with other data from the GCRMS system and 4) stimulate to improved return rate and minimize the risk of mistakes and misunderstandings in the trial work.

# Methods

The raw data from the trials, disease severity and infection type and other attribute data are stored in an SQL database in the Wheat Rust Toolbox. Tools for the management of data, data entry web pages and display tools are programmed with .NET technology. A user database controls login and user access to restricted tools and features. There are no public



pages on the Wheat Rust Toolbox. All tools that are aimed at public access are produced by the system as "show versions" – dynamic web applications that can easily be embedded in any website – similar to the survey mapper and other tools from the Wheat Rust Toolbox in RustTracker and at the GRRC web site.

We aim to coordinate and integrate the Trap nursery information with the screening nursery DB hosted by Cornell University and with host resistance information in the Wheat Atlas hosted by CIMMYT and RustTracker. This will be secured via the DRRW ICT and communication group.

## Results

#### System description and dataflow

All database tables and web tools utilize features in the Wheat Rust Toolbox ICT framework. Dataflow and system description of the Rust Trap Nursery DB and Dissemination Tools is given in Fig. 1.



**Figure 1.** The Rust Trap Nursery Data Management System, dataflow, dissemination and ICT framework. The dotted lines indicate the system is prepared for this activity, but not yet implemented.

The TN management system is included in the Wheat Rust Toolbox and it has its own top menu and associated sub-menus (Fig 2. and list below). The models and application layer holds a range of tools and features some with restricted access based on user login. Some tools are only available for the TN manager group (2-3 people). The results are evaluated by an expert group that will have user login too. The role of this group is to analyse the data and make a yearly report about the results including interpretations and perspectives in a GCRMS context. The target audiences will be the breeding community, farmers and extension services as well as the scientific community. The use of different tools is described briefly in the list below.





**Figure 2.** Trap Nursery menu structure in the Wheat Rust Toolbox. Trap Nursery management tools are only available for the TN management group. Analysing tools including access to raw data are only available for the TN management and Expert group. Edit observations (enter results) and My Trap Nursery are only available for TN users ad public output are selected tools aimed to be embedded in external web sites.

A trial and the associated test results can have different status:

- 1. Trial distribution set sent and trial established in the Toolbox, no data returned (yet)
- 2. Results returned and data are in an evaluation process
- 3. Trial results quality controlled

For the evaluation process, results with status 2 and 3 will be included on maps, tables and graphics. Only results with status 3 will be publicly available. It is only the TN manager group that can change status for trial results. Currently Kumarse and Jens are marked TN manager.

Expert panel (Decided in New Delhi):

- Robert Park (robert.park@sydney.edu.au)
- Yue Jin (yuejin@umn.edu)
- Tom Fetch (Tom.Fetch@AGR.GC.CA)
- Zakkie Pretoius (PretorZA@ufs.ac.za)
- Mogens Hovemøller (Mogens.Hovmoller@agrsci.dk)
- Dave Hodson (D.Hodson@cgiar.org)
- Kumarse Nazari (K.Nazari@cgiar.org)

The TN user group will be all contact people for the Trap Nurseries (Table 1).



## Table 1. International Trap Nursery Contact Names and Institutions, 2013

Country	Contact names	Institution
Afghanistan	Javed Rizvi, Noor Haq Hak & Rajiv Sharma	
Algeria	Kaddour Ben Belkacem	
Armenia	Zoia Sikharulidze	
Azerbaijan	Javansir Talai & Konul Aslanova	
Bangladesh	Paritosh Kumar Malaker & A.B. Siddique	
Bhutan	Mahesh Ghimiray	
Egypt	Sami Reda Sabry & Abd Elkader Hasan &	
	Mohamed Abou Zeid	
Eritrea	Wolday Asmelash Tecle	
Ethiopia	Bedada Girma & Ayele Badebo & Getaneh Wolderufael & Geletu Beiiga	
Georgia	Zoja Sikharulidze	
India	Mohinder Prashar	
Iran	Farzad Aafhari & Moitabah Vahabzadeh &	
	Mehran Patpour	
Iraq	Emad M. Al-Maaroof	
Kazakhstan	Rsaliyev Shynbolat	
Kenya	Ruth Wanyera	
Kyrgyzstan	Ram Sharma	
Lebanon	Rola Al Amil	
Libya	Habib Ktata &Ibrahim Ben Amer	
Morocco	Ramdani Abdelhamid	
Nepal	Surath Pradhan & Deepak Bhandari & S. Sharma &	
Oman	Hamoud Darwish Al Hasani	
Pakistan	Atiq Rattu	
Saudia Arabia	Abdulaziz Ibraheem Alzamil	
South Africa	Zakkie Pretorius	
Sudan	Abdalla Mohamed Kurmut	
Syria	Kumarse Nazari & Munzer Naimi	
Tajikistan	Mahbubjon Rahmatov	
Tunisia	Mohammed El Mourid	
Turkey	Zafer Mert & Mesut keser	
Turkmenistan	Ram Sharma	
Uzbekistan	Zafar Ziyaev & Ram Sharma	
Uruguay	Silvia Germán	
Yemen	Abdullah Sailan	
Denmark	Lars Eriksen	



#### **Trap Nursery Management menu structure**

- > Trap Nursery management (Restricted to TN management group)
  - Cultivars (enter, edit and delete cultivars and associated resistance genes)
  - Differential sets (define differential sets based on cultivar DB)
  - **Distribution sets** (define Distribution sets based on Diff. sets + mega and local cultivars.
  - Trial sites (enter edit and delete Trial sites.
  - Trials (enter, edit and delete trials by country and year)
  - User management (enter edit and delete TN users)
- > Analysing tools (as tab pages) (Restricted to TN Expert group)
  - Infected Trials Map (Dynamic map only trials with severity on Morocco > certain severity level)
  - Cultivar Map (Dynamic map High/low results for cultivars only trials with severity on Morocco > certain severity level and only severity on selected cultivar lower than a certain attack level and Infection type lower than a certain infection type class.
  - Cultivar rank list (Similar to Cultivar Map but in a multi sortable list)
  - **Genes Map** (Similar to Cultivar Map, but for single resistance genes analyse results for all cultivars containing the resistance gene selected)
  - Genes Rank List (Similar to Gens Map but in a multi sortable list)
  - Genes Rank Map (Similar to Genes Rank list but in Bar Graphics)
- > Edit Observations enter results (Restricted to TN users group)
- My Trap Nursery (Restricted to TN users group)
  - Trial site map (Map with trial sites by year)
  - Infected Trials Map (Dynamic map only trials with severity on Morocco > certain severity level )
  - **Cultivar Map** (see Analysing tools)
  - Genes Map (see Analysing tools)
  - **Download own results** (Download own country results in csv and XML)
- Public output (Show versions to be embedded in external web pages))
  - To be discussed by the expert panel



#### Steps in system development and use

To understand how the system was developed and how it is intended to be used, we describe this step by step:

- All differential cultivars, mega cultivars and local cultivars were implemented into the Host-Pathogen database – including cultivar specific known resistance genes.
- A login protected system for the management (new, delete, edit) of trial sites and trials was developed. Established trials are available on a Google map.
- A login protected web tool was developed that stepwise generated a distribution set based on differential, mega and local cultivars in the database. In the last step, the distribution set is linked to the trials.
- By default, the results were generated as no disease for each cultivar in the trial.
   Upload of data is then by editing the default values.
- The responsible TN partners can login and Edit own results, but TN manager will make data public after quality control in the Wheat Rust Toolbox.
- Draft display tools shows i) map with trial locations where Check cultivar Morocco was attacked more than a certain threshold 2) Maps and tables indicating where and how much single cultivars are attacked and 3) Map, tables and graphics indicating if certain resistance genes are active or not
- My Trap Nursery especially target TN partners, aiming at analyzing and download of own data.
- The analysis tools especially target the Expert group that after login finally can "Checkmark" which rust resistance genes are considered to be active or not on each and single trial sites tested.
- Tools will be developed that link results of Pathogen characterization at GRRC (pathotyping) or other labs (could be SNP Molecular diagnostic) with Trial location ID
- Results of pathotyping from Trap nurseries will be integrated with data from similar Pathotyping activities and presented on a Rust Pathotype Mapper (Google map with pathotype and virulence information across years and countries)



# **Examples of tools and web interfaces**

#### **Trial site management**

Select Trial sites menu and then select New trial site and enter name, country, Lat /Long and altitude (Fig 3)

W		ST TOOLB	ох									
Home	Wheat Rust survey	Wheat Rust isolates	Barberry	Trap nurseries	Rust management	Database	Partners				jgh <mark>log</mark>	out
Under Trial st	test TES											
Country	Na	ame					Latitude	Longitude	Altitude	Edit	Delete	
Afghanis	tan Ea	astern Zone					32.40830	66.54590	508.00	2		^
Afghanis	tan No	orth East Zone					31.41170	62.26470	915.00	Z		
Afghanis	tan No	orth Zone					33.35540	66.54590	465.00	Z		
Armenia	Ec	hmiadzin					40.16667	44.28333	850.00	Z		
Azerbaija	in Sh	neki					40.89080	47.18790	201.00	Z	Ē	=
Banglade	esh Di	inajpur					25.73330	88.66670	40.00	Z		
Banglade	esh Ga	azipur					24.00000	90.41670	8.00	Z	Ē	
Banglade	esh Ja	malpur					24.93330	89.91670	17.00	Z		
Banglade	esh Je	ssore					28.18330	89.23330	7.00	Z	Ē	
Banglade	esh Ra	ajshahi					24.36670	88.65000	18.00	Z	1	
Egypt	Ge	emmeiza					30.79490	31.12310	6.00	Z	Ē	
Egypt	N	ubaria					31.16690	29.94250	39.00	Z		
Egypt	Sa	akha					31.09860	30.95030	11.00	Z	Ē	
Egypt	Sie	da					28.92350	30.97380	51.00	Z	1	
Iraq	Ai	inkawa					36.25178	43.99587	430.00	Z	Ē	
Iraq	A	Wehda					37.94980	38.04580	73.00	Z	1	
Iraq	Ba	akrajo					35.32264	45.21911	691.00	Z	Ē	
Iraq	Ku	ut					32.44140	44.56670		Z	1	
-							26 25 211	12 20010	271.00	=2	-	<b>V</b>
New tri	al site											

Web site provided by <u>Aarhus University. Faculty of Science and Technology. Department of Agroecology.</u> Report technical problems to webmaster: <u>Poul Lassen</u>. Optimized for screen size 1024x768

**Figure 3.** Trials sites management. TN manager can enter, edit and delete trial sites and attribute data.



#### **Trial management**

Select year and then the button New trial. Affiliate with Trial site, Host species and Pathogen Species tested for. A trial site can have more than one trial in the same year e.g. stem rust TN and a stripe rust TN. Trial sites can be the same year after year. New trial names must be established each year. When more data is collated it will be possible to analyse data across years on the same trial site.

Wн	eat Rust 1	ΓΟΟΙΒΟΧ						
Home W	/heat Rust survey Wheat	Rust isolates Barberry Trap n	urseries Partners				e jgh <mark>log</mark> e	out
Test vers TRIALS Year @ 2013	sion © 2012 © 2011 © 2010							
Status 👻	Country	Trial site	Trial	Pathogen	Edit	Info	Delete	
Returned	Afghanistan	North Zone	North Zone	Stem rust (Puccinia graminis)	Z	Þ	Ē	-
Returned	Bangladesh	Dinajpur	Dinajpur	Stem rust (Puccinia graminis)	Z	⇒	1	
Returned	Georgia	Kobuleti	Kobuleti	Stem rust (Puccinia graminis)	2		Ē	
Returned	Islamic Republic of Iran	Kelardasht	Kelardasht	Stem rust (Puccinia graminis)	Z		1	Ξ
Returned	Lebanon	Terbol	Terbol	Stem rust (Puccinia graminis)	2	-	Ē	
Returned	Pakistan	CDRI Karachi	CDRI Karachi	Stem rust (Puccinia graminis)	2		<b></b>	
Returned	Tajikistan	Gissar Region, Sharora Settlement	Tajikistan	Stem rust (Puccinia graminis)	2		Ē	
Returned	Turkey	AARI Izmir	AARI	Stem rust (Puccinia graminis)	2	<b>&gt;</b>	<b></b>	
Distributed	Afghanistan	Eastern Zone	Eastern Zone	Stem rust (Puccinia graminis)	2		Ē	
Distributed	Afghanistan	North East Zone	North East Zone	Stem rust (Puccinia graminis)	2	⇒	<b></b>	
Distributed	Armenia	Echmiadzin	Echmiadzin	Stem rust (Puccinia graminis)	2		<b></b>	
Distributed	Azerbaijan	Sheki	Sheki	Stem rust (Puccinia graminis)	2		<b></b>	
Distributed	Bangladesh	Gazipur	Gazipur	Stem rust (Puccinia graminis)	2	•	Ē	
Distributed	Bangladesh	Jamalpur	Jamalpur	Stem rust (Puccinia graminis)	Z		1	
Distributed	Bangladesh	Jessore	Jessore	Stem rust (Puccinia graminis)	2	•	Ē	
Distributed	Bangladesh	Rajshahi	Rajshahi	Stem rust (Puccinia graminis)	2		<b></b>	
Distributed	Egypt	Gemmeiza	Gemmeiza	Stem rust (Puccinia graminis)	2		Ē	
Distributed	Faynt	Nubaria	Nubaria	Stem rust (Puccinia graminis)	2	•	m	Ŧ
New trial	ne Contact ema	I Institution name	Institution address	Institution email Obs	ervation date		Ed	it
No records to	o display.							

Web site provided by <u>Aarhus University, Faculty of Science and Technology, Department of Agroecology</u>. Report technical problems to webmaster: Poul Lassen. Optimized for screen size 1024x768

**Figure 4.** Overview and entry of new trials. A trial can have three values for status. Distributed, Returned and QC (Quality Controlled). In this example the table is sorted according to the column variable "Status".

The number of trials in 2012 and 2013, the return rate and number of trials with infection on morocco>=20% is given in Table 2. In 2012 and 2013, the return rate was 55% and 16% respectively. In 50-60 percent of the trials returned, infections occurred on the susceptible check cultivar Morocco. It is valuable information to know if no disease pressure occurred in the trial, but a certain infection pressure is needed for the evaluation of the effectiveness of the resistance genes / cultivars tested.

#### Table 2. Number of trials and return rate

Year	No of trials	No of returns	Return rate	No Trials with Infection*
2012	44	24	55%	12 of 24 (50%)
2013	49	8**	16%	5 of 8 (63%)

\*Trials with infection on one or more of Morocco Check cultivar reps of 20%

\*\* Status on 12 August 2013



#### Differentials, mega and local cultivars

Differentials where included from the BGRI core differential set and from the DRRW TN Distribution set, 2012 and 2013 used by ICARDA. You can make a NEW CULTIVAR, DELETE and you can EDIT a cultivar including the variables = Cultivar name, Gene, Origin and Source (Fig. 5)

WHEAT RUST	TOOLBOX			
Home Wheat Rust survey Whe	eat Rust isolates Barberry	Trap nurseries Rust management Dat	abase Partners	Welcome jgh logout
Under test				
Type	Mega O Local	DIFFERENTIALS AND OTHER COLLIVARS		
Cultivar	Gene	Origin	Source	Edit Delete
07GH	Trident			2 📅 🔺
944 236-1 Marquis "B"	Sr19			2 📾
94A 237-1 Marquis "C"	Sr20			2 8
Acme CI 5284	Sr09a	Selection from Kubanka (CI 1516)	Pretorius, SA	1 1
Agatha (CI 14048)/9*LMPG-6 DK16	Sr25			2 1
Barleta Benvenuto (CI 14196)	Sr08b			2 🔒
Chinese Spring*5/Thatcher 3B	Sr12			2 8
Chinese Spring*7/Marquis 2B	Sr09a	Selection from Kubanka (CI 1516)		2 💼
CI 14167/9*LMPG-6 DK04	Sr08a	Red Egyptian/CS (CI 14167)		2 💼
CnsSrTmp	SrTmp	Triumph 64 (CI 13679)/Chinese Spring	Jin. USDA	2 💼
Eagle Sr26 McIntosh	5r26	·······		2 1
ER5155 S-203 (1995)Roelfs	Sr32			2 🗇
Exchange CI 12635	Sr23			2 1
Festiquay W2706 PI 330957	Sr30	Festival / Uruguay C10837	Park Australia	2 📾
ISr5-Ra CI 14159	Sr05	Thatcher/Chinese Spring		2 1
ISr6-Ra CI 14163	Sr06	Red Egyptian/Chinese Spring		2 📾
ISr7b-Ra (T 14165	Sr07b	Hone/Chinese Spring		2 1
ISr9a-Ra (T 14169	Sr09a	Red Egyptian/Chinese Spring		2 📾
ISr9d-Ra CI 14177	Sr09d	Hope/Chinese Spring		
New cultivar				
	Web site provided by <u>Aarh</u>	us University, Faculty of Science and Technology, I	Department of Agroecology.	
WHEAT RUST	TOOLBOX	opening of webning cert		
Home Wheat Rust survey Whe	eat Rust isolates Barberry	Trap nurseries Rust management Dat	abase Partners	Welcome jgh
Under test Type ③ Differential	○ Mega ○ Local	DIFFERENTIALS AND OTHER CULTIVARS	5	
Cultivar	Gene	Origin	Source	Edit Delete
07GH	Trident			2 💼 🛆
94A 236-1 Marquis "B"	Sr 19			2 💼
94A 237-1 Marquis "C"	Sr20			2 🗇
Acme CI 5284	Sr09 Edit cultivar 'Acme G	15284'	orius, SA	2 🗇 🚪
Agatha (CI 14048)/9*LMPG-6 DK16	Sr25 Cultivar Acme CI 52	84		2 🗇
Barleta Benvenuto (CI 14196)	Sr08 Gene Sr09g			2 🗇
Chinese Spring*5/Thatcher 3B	Sr 12 Origin Selection fr	om Kubanka (CI 1516)		<b>Z</b>
Chinese Spring*7/Marquis 2B	Sr05 Source Pretorium	Δ		<b>Z</b>
CI 14167/9*LMPG-6 DK04	Sr08 Caura Const	-		2 1
CnsSrTmp	SrTi		, USDA	<b>X</b> 📅
Eagle Sr26 McIntosh	Sr26			2 1
ER5155 S-203 (1995)Roelfs	Sr32			× 💼
Exchange CI 12635	Sr23			2 1
Festiguay W2706 PI 330957	Sr30	Festival / Uruguay C10837	Park Australia	× 🖷

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Thatcher/Chinese Spring

Hope/Chinese Spring

Red Egyptian/Chinese Spring

Red Egyptian/Chinese Spring

ISr5-Ra CI 14159

ISr6-Ra CI 14163

ISr7b-Ra CI 14165

ISr9a-Ra CI 14169

ISr9d-Ra CT 14177 New cultivar Sr06

Sr07b

Sr09a

**Figure 5.** The cultivar DB is divided into three groups of cultivars, Differentials, Mega cultivars and local cultivars. The user can make a new cultivar and edit existing cultivars. Click on 1-3 Table header names for multiple sorting.

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The TN manager can define a Distribution set based on differentials, mega cultivars and some local cultivars

You can shift between differentials, mega cultivars and local cultivars with the radio buttons above the table (Fig. 6)

WHEAT RUST	TOOLBOX					
Home Wheat Rust survey W	/heat Rust isolates Barberry	Trap nurseries Rust management Database	Partners		; jgh <mark>log</mark>	out
Under test		DIFFERENTIALS AND OTHER CULTIVARS				
lype O Differenti	ial 💿 Mega 🔾 Local					
Cultivar	Gene	Origin	Source	Edit	Delete	
Aguilal		Morocco				Ê
Altar						
Amigo	Sr24, Sr1RS-Am	Hard red winter				
Arrehane		Morocco		2		4
Bacanora = Kauz's'	Sr31			-2		
Bt/WId	SrWId-1					
Cham 10 = Kauz//Kauz/star		Syria		-2		
Cham 6		Syria		2		
Cham 8	5r31	-		-2		
Chamran = Attila		Iran		2		
Chris	Sr/a, Sr12,Sr0			-2		
Cook	5r30			2		
Coorong (Triticale)	Sr27			-2		
CsSSrTmp	SrImp	08 Aberdean Inc. Source: 06 AB YJ		2		
Debeira	6 M	Sudan		-2		
Einkorn	Sr21	- ·		2		
EL Nielain		Sudan		-2		
Fleming	Sr6, Sr24, Sr36, Sr1RS-Am	Soft red winter				
Gemmeiza 9 New cultivar		Eavpt				

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**Figure6.** Interface with list of mega cultivars. Click on Table header name for sorting the table.

#### **Definition of differential sets**

First step is to define a differential set based on the differentials database. Currently, two sets are defined:

- BGRI International Core Differential Set
- BGRI Trap Nursery Differential Set

The TN Manager can define a new differential set by selecting differentials from a drop down list with checkmarks for each of the differentials in the database (Fig. 7) After selecting the relevant differentials then select the button Add Differentials to Differentials Set.



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**Figure 7**. Select differentials for the Test Differential set (Marked in Orange) in Differential sets table

WHEAT RUST	r <b>T</b> oolb	ох				<b>AR</b>			
Home Wheat Rust survey V	/heat Rust isolates	Barberry	Trap nurseries	Rust manageme	nt Databas	e Partners			hlogout
Under test DIFFERENTIAL SETS									
Differential set							Edit	Differentials	Delete
BGRI International Core Differentia	l Set						Z	*	Ē
BGRI Trap Nursery Differential Set							Z		Ē
Test Diff set Jens							Z		
New differential set									
Discontinue									
DIFFERENTIALS	•	Add diffe	arantials to differentia	al cat					
o items checked		Add diffe	erentials to differentia	arset					
Cultivar	Gene	Origin			ource				
94A 236-1 Marquis "B"	Sr19								
94A 237-1 Marquis "C"	Sr20								
Agatha (CI 14048)/9"EMPG-6 DK IG	Sr25								
Barleta Benvenuto (CI 14196)	Sr08b								
Chinese Spring*5/Thatcher 3B	Sr12								
Chinese Spring*7/Marquis 2B	Sr09g	Selection	from Kubanka (CI 15	16)					

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Figure 8. Six items selected is now included in the Test Differential Set



#### **Definition of Distribution set**

A Wheat rust trap nursery distribution set is the set of cultivars used in the trap nursery network organized by ICARDA in the DRRW project.

The distribution set comprise a differential set, some mega cultivars and some local cultivars. It might be expected that the differential set will be stable for the next 1-5 years, but some Mega and some local cultivars will be added to the sets to distribute.

The current set used in 2012 is called BGRI Trap Nursery Distribution set 2012. A new set can be defined every year, but the intention of comparison of results across regions and years requires a reuse of the majority of cultivars.

To define the distribution set there are 6 steps to go through (Fig 7 and Table 3). In the final step the distribution set is affiliated with the trials defined in the year selected. If additional trials are decided at a later stage, Trials are defined under TRIALS and step 6 under DISTRIBUTION SET is done again. Existing distributions sets will not be overwritten but new are appended.

W	HEAT RU	st Toolb	ох					
Home	Wheat Rust survey	Wheat Rust isolates	Barberry	Trap nurseries	Rust management	Database	Partners	Welcom
Under DISTRIB < Baa	test UTION SETS ckward Forward	> SET						
Name		Description						Ed
BGRIT	ap Nursery Distributior distribution set	set 2012 Distribution	set used in 2	012, West and Cent	ral Asia. Organised by I	carda		E
		Web site provi Report	led by <u>Aarhu</u> technical pro	s University, Faculty blems to webmaste	of Science and Technol r: Poul Lassen, Optimize	ogy, Departn d for screen	nent of Agroeco size 1024x768	logy.

**Figure 9.** Step one for defining a distribution set. Select the Button New Distribution Set and follow the instructions during step 1-6.



Step	Description
Weat Ray Toolax     Region (Region (Regin (Region (Region (Region (R	1 Select Button New distribution set
	2 Select Differential set from Drop down list and press button: Add differential set to distribution set
	3 Select mega cultivars from drop down list and press the button: Add mega cultivars to distribution set
	4 Select local cultivars from drop down list and press the button: Add local cultivars to distribution set
	5 STEP 5: SORT CULTIVARS IN DISTRIBUTION SET BGRI Trap Nursery Distribution set 2012
WHEAT RUST TOOLOOX	6 STEP 6: ADD DISTRIBUTION SET TO TRIAL RCRITICON Numery Distribution set 2012 Trial year (© 2012 Selected distribution

After step 6 results can be entered directly into the Database via the menu item Edit Observations



#### Edit observations - trap nursery data entry web form

Select Edit Observations for data entry. Select year and then select tre trial name from the drop down list.

WHEAT RUST TOOLBOX				
Home Wheat Rust survey Wheat Rust isolates Barberry Trap nurseries	Rust management Da	itabase Partners		jgh logout
Under construction TRIAL OBSERVATIONS Year © 2012 Titals Syrian Arab Republic, tel Hadya				
Cultivar	Gene	Severity	Infection type	Edit
Triticale Start	Check cultivar	10	R	
ISr5-Ra CI 14159	Sr05	60	S	2
ISr6-Ra CI 14163	Sr06	50	S	
Na 101/6*Marquis	Sr07a	20	R	2
ISr7b-Ra CI 14165	Sr07b	60	S	
CI 14167/9°LMPG-6 DK04	Sr08a	60	S	2
Barleta Benvenuto (CI 14196)	Sr08b	70	S	2
ISr9a-Ra CI 14169	Sr09a	70	S	2
Prelude*4/2/Marquis*6/Kenya 117A	Sr09b	70	S	2
ISr9d-Ra CI 14177	Sr09d	70	S	2
Vernstein PI 442914	Sr09e	70	S	2
Chinese Spring*7/Marquis 2B	Sr09g	70	S	2
W2691Sr10 CI 17388	Sr10	60	MS	Z
Lee/6*LMPG-6 DK37	Sr11	40	MR	2
Chinese Spring*5/Thatcher 3B	Sr12	70	S	2
Prelude*4/2/Marquis*6/Khapstein	Sr13	60	M	2
W2691*2/Khapstein	Sr14	60	S	2
Prelude*2/Norka	Sr15	70	S	Z
Thatcher/CS (CI 14173)	Sr16	70	S	2
Morocco A	Check cultivar	70	S	2 💌

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WHEAT RUST TOOLBOX					S.			-	18
Home	Wheat Rust survey Wheat R	ust isolates	Barberry	Trap nurseries Partne	ers			jgh <mark>log</mark>	gout
<b>Under</b> TRIAL OI Year Trials	Construction ISERVATIONS © 2013 © 2012 Egypt, Gemmeiza	Ŧ							
Cultivar				Gene	Severity	Infection type	No.	Edit	1
Triticale	Start			Check cultivar	No disease	N/A	1	N	*
ISr5-Ra	CI 14159			Sr05	No disease	.N/A	2	M	
ISr6-Ra	14163			Sr06	No disease	N/A	3	N	-
Na 101/	i*Marquis			Sr07a	No disease	N/A	4	Z	
ISr7b-Ra	CI 14165			Sr07b	No disease	N/A	5		
CI 14167	/9*LMPG-6 DK04					-	6	Z	
Barleta i	Senvenuto (CI 14196)	vation on 'ISr7	b-Ra (111	65%		×	7		
ISr9a-Ra	CI 14169 Severity	© N/A	O No dise	ase 🔘 1 🔘 5 🔘 10 🔘 20	0 30 0 40 9 50 0 60	◎ 70 ◎ 80 ◎ 90	8	Z	
Prelude	4/2/Marquis*6/Kenya	◯ 100	0.0.		0.0		9	Z	
ISr9d-Ra	CI 14177	pe ON/A	⊙ R ♥ R-		(MR-MS) OM-MS OM	S O MS-S O S	10	Z	
Vernstei	n PI 442914	Cancel		anaza.		19775	11	Z	
Chinese	Spring*7/Marquis 2B			Sr09g	No disease	N/A	12	Z	
W26915	r10 CI 17388			Sr10	No disease	N/A	13	2	
Lee/6*LI	IPG-6 DK37			Sr11	No disease	N/A	14	2	
Chinese	Spring*5/Thatcher 3B			Sr12	No disease	N/A	15	Z	
Prelude	4/2/Marquis*6/Khapstein			Sr13	No disease	N/A	16	×	
W2691*	2/Khapstein			Sr14	No disease	N/A	17	Z	
Prelude	2/Norka			Sr15	No disease	N/A	18	Z	
Thatche	/CS (CI 14173)			Sr16	No disease	N/A	19	Z	
									-

**Figure 10**. Edit observation. Trap Nursery responsible contact person upload results from the trial at this stage



The Disease severity classes and the infection type scale are more detailed compared to the wheat rust surveillance scale used in GCRMS (Table 4 and Table 5).

#### Table 4. Disease severity classes

Severity ID	Disease severity
-9	N/A
0	0
1	1
2	5
3	10
4	20
5	30
6	40
7	50
8	60
9	70
10	80
11	90
12	100

#### Table 5. Infection type classes

Infection type ID	infection type name
-9	N/A
1	R
2	R-MR
3	MR
4	MR-M
5	M (MR-MS)
6	M-MS
7	MS
8	MS-S
9	S



#### **Infected Trials Map**

In 2012, seeds were distributed to 44 International Trap Nurseries in Central and West Asia and Africa. The return rate was 55%, but only 12 trials were actually infected with stem rust. To analyse and display this situation we developed the tool called "Infected trials" (Fig. 11). The user selects the year and then a disease severity threshold. Click the show button to update the map. The map will show trial locations with different colors indicating the status of the trial results depending on selections: Grey dots indicate trials where seeds were sent but no results returned. Orange dots indicate that one or more of the check cultivars, Morocco, had 20% or more disease severity recorded. Green dots indicate that all disease severity recordings on Morocco were less than 20% severity. The user can change the threshold according to a dropdown list similar to the Disease severity classes used for disease severity scoring in the trial (Table 4). The similar information in text is given just above the map. The objective of the Infected Trials map is to be able to analyse from which trials one can expect reliable results for test of cultivars / resistance genes. If one accepts the threshold of 20% disease severity for Morocco, it means that 12 trials can provide information on effectiveness of stem rust resistance genes in 2012 on selected locations. If samples were sent to a reference lab for characterization there will be established a link between the trap nursery information and pathotype / genotype information.



**Figure 11.** Infected Trials map. The user selects the year and then a disease severity threshold. Click the show button to update the map. The map will show trial locations with different colors indicating the status of the trial results depending on selections. See text for further information.



#### **Cultivars Map**

To analyse and display the resistance of single cultivars we developed the tool called "Cultivars Map" (Fig. 12). The user selects the year, the disease severity threshold ( $\geq$ ) for Morocco (trials to be included), and the level of disease severity and infection type for the cultivar of interest. This selection discriminates if dots on the map become Green ("healthy") or Orange ("infected"). In the example below, for 2012, 12 out of 24 trials were selected for the test because in these trials at least one replicate of Morocco had infections  $\geq$  20%. The cultivar Sr31 (Benno)/6\*LMPG-6 DK42, containing the SR 31 resistance gene was selected for test. The map shows on which of the 12 selected locations disease severity on Sr31 (Benno)/ 6\*LMPG-6 DK42 was  $\leq$  20% and at the same time the infection type was "MR" or better (green dots). All alternatives are in orange color. The similar information is given just above the map in a dynamic generated text:

"In 12 trials, severity in at least one of the Morocco plots were 20% or higher. In 8 of those trials, severity was equal to or lower than 20% and infection type equal to or lower than MR for the cultivar selected: 'Sr31 (Benno)/6\*LMPG-6 DK42'."



**Figure 12.** Cultivars map. The user select year, threshold for disease severity on Morocco, the cultivar name for test, and thresholds for disease severity and infection type for the cultivar selected. The map show on which locations the cultivar has severities and infection types equal to or lower than the selected thresholds. Click on the dots to see attribute data for a specific location.



The objective of the Cultivars map is to analyse the stability of resistance of differentials and mega cultivars under variable growing conditions and exposed to current and local pathogen populations.

The information in Figure 12 corresponds well with the knowledge on the distribution of UG99 variants (that overcome the SR31 resistance gene), that SR31 virulent races are found in east Africa, South Africa and in West Asia as far as Iran. Stem rust is found in low elevated (hot) areas in e.g. Pakistan, but so far no SR31 virulent races.

#### **Cultivars Rank list**

The cultivar rank list is a supplement to the cultivar map. ). The user selects the year, the disease severity threshold (≥) for Morocco (trials to be included), and the cultivar of interest. The drop down list is a sorted list of all Differential, Mega and Local cultivars tested in the trials in the selected year. In the example, Fig. 13, the differential cultivar, Sr31 (Benno)/6\*LMPG-6 DK42 was selected. Results are then sorted according to Disease severity and then Infection type. The users can multiple sorting, - ascending or descending by selecting the header titles for up to three columns.

As we selected the same gene and same threshold for attack on Morocco, the table actually shows the data behind the colored dots in Fig. 12. Thresholds for "gene effective" was set as Disease severity  $\leq 1$  and "Infection type"  $\leq R$  (means R or N/A). This holds true for two of three trials in Egypt and the two trials in Pakistan. In the eight other trials results did not fulfill the user-defined setting for "gene active". If those settings were change to 5% severity and MR infection type, then the SR31 gene was only ineffective in Iran, Kenya and Sudan.

WHEAT R	WHEAT RUST TOOLBOX					
Home Wheat Rust sun	rey Wheat Rust isolates Barberry Trap nurseries Partners		elcome jgh <mark>logout</mark>			
Show       Year       2013       2012       Select trials with severity on Morocco equal to or higher than       20       20         Show       Cultivar       Sr31 (Benno)/6*LMPG-6       DK42       Gene(s): Sr31						
Country	Trial	Disease severity 🔺	Infection type 🔺			
Egypt	Gemmeiza	0	N/A			
Egypt	Sida	0	N/A			
Pakistan	Kunri	0	N/A			
Pakistan	Thatta	0	N/A			
Egypt	Nubaria	1	MR			
Syrian Arab Republic	tel Hadya	5	R			
South Africa	Greytown	5	MR			
Islamic Republic of Iran	Kelardasht	20	MR			
Kenya	Eldoret	20	MS-S			
Kenya	Kinamba	50	MS			
Sudan	New Halfa	60	MR			
Kenya	Njoro	80	S			

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**Figure 13**. Cultivar Rank list. The table is sorted according to Disease severity and infection type. See text for further explanation.



#### **Genes Map**

In the Trap Nurseries the differentials represent (aimed at) one single resistance gene. For the mega cultivars and local cultivars, some includes more than one resistance gene, for some cultivars the resistance complex is unknown and more mega cultivars may contain the same resistance genes. To evaluate the effectiveness of a single gene (across several cultivars with the same gene), by location and year we developed the Genes map tool (Fig. 14) and the Genes Rank List (Fig 15). A gene is defined as effective if all results on a location obtain severities  $\leq 20\%$  and at the same time the infection type as "MR" or better (green dots). All alternatives are in orange color. In the example in Fig. 14, the gene SR31 is effective (for all cultivars tested containing SR31) on 6 of 12 locations in 2012, in all three trials in Egypt, two trials in Pakistan and one in Syria. This information is displayed on Google maps and just above the map in a dynamic generated text:

"In 12 trials, severity in at least one of the Morocco plots were 20% or higher.

In 6 of those trials, severity was equal to or lower than 20% and infection type equal to or lower than MR for all cultivars containing the gene 'Sr31'"



Figure 14. Gene map tool. See text for further explanation



#### **Gene Rank list**

The Gene rank list is a supplement to the Gene map. The user selects the year, the disease severity threshold (≥) for Morocco (=trials to be included), and the gene of interest. The drop down list is a sorted list of all genes identified in the Cultivar database. In the example, Fig. 15, the gene Sr31 was selected. Results were then multiple sorted according to Cultivar, Disease severity and then Infection type. The users can multiple sort, - ascending or descending by selecting the header titles for up to three columns. Results in the table show that the SR 31 gene in the cultivar Cham8 was effective in 2012 in all three trials in Egypt, both trials in Pakistan, Sudan, South Africa and Syria, but not in Kenya (Fig. 15)

WHEAT RUST T	OOLBOX	(A				
Home Wheat Rust survey Whea	t Rust isolates Barberry Trap nurser	ies Partners		Welcome jgh		
Jnder construction       SENES       Gene map       Gene rank list       Year       2013 (2012)       Select trials with severity on Morocco higher than       20						
Country	Trial site	Cultivar 🔺	Disease severity 🔺	Infection type 🔺		
Egypt	Gemmeiza	Cham 8	0	N/A		
Egypt	Nubaria	Cham 8	0	N/A		
Egypt	Sids	Cham 8	0	N/A		
Pakistan	Kunri	Cham 8	0	N/A		
Pakistan	Thatta	Cham 8	0	N/A		
South Africa	Greytown	Cham 8	1	R		
Syrian Arab Republic	Tel Hadya	Cham 8	1	R		
Sudan	New Halfa	Cham 8	10	R-MR		
Kenya	Kinamba	Cham 8	30	M (MR-MS)		
Kenya	Eldoret	Cham 8	70	S		
Kenya	Njoro	Cham 8	70	S		
Islamic Republic of Iran	Kelardasht	Cham 8	80	MS		
Egypt	Gemmeiza	PBW343 = Attila with Sr31	0	N/A		
Egypt	Sids	PBW343 = Attila with Sr31	0	N/A		
Pakistan	Kunri	PBW343 = Attila with Sr31	0	N/A		
Pakistan	Thatta	PBW343 = Attila with Sr31	0	N/A 🔻		

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**Figure 15.** Gene Rank list. Sorted according to Cultivar, Disease severity and Infection type. See text for explanation.

It is relevant to ask the question if all cultivars containing SR31 obtain similar results on the same trial location. Use the gene rank list and sort according to Trial site name, Disease severity and the Infection type. In the example, Fig. 16, Seven cultivars tested included SR31: Bacanora = Kauz's'; Cham8; PBW343 = Attila with Sr31; Sisson; Seri 82; Sr31 (Benno)/6\*LMPG -6 DK42 and Siouxland. Using the threshold of 1 % severity <u>and</u> Infection Type = R. The results show that at Tel Hadya in Syria, 5 of 8 cultivars were tested "gene active" (Fig 16). But, if thresholds were selected as 10% severity and infection type = R, then all cultivars were tested "gene active". All cultivars tested at Tel Hadya obtained infection type=R and it is probably reasonable to accept up to 10% severity if reaction type is R or R-MR – for the final scoring of "gene effective".



NHEAT	RUST	TOOLBO

lome Wheat Rust survey	Wheat Rust isolates Barberry	Trap nurseries Partners		Welcome jgh 😡
nder construction ENES Gene map Gene rank list Show Year Gene Sr31	t Gene rank chart © 2013 🕲 201	2 Select trials with severity on Mo	rocco higher than 20 💌	
Country	Trial site 🔺	Cultivar	Disease severity 🔺	Infection type 🔺
Egypt	Side	SiSI (Berno)/6"LWPG-6 DK42	5	MP
Syrian Arab Penublic	Tel Hadva	Bacapora – Kauz's'	1	D
Syrian Arab Republic	Tel Hadva	Cham 8	1	R
Syrian Arab Republic	Tel Hadya	PBW343 = Attila with Sr31	1	R
vrian Arab Republic	Tel Hadva	Sisson	1	R
iyrian Arab Republic	Tel Hadya	Seri 82	5	R
yrian Arab Republic	Tel Hadya	Sr31 (Benno)/6*LMPG-6 DK42	5	R
iyrian Arab Republic	Tel Hadya	Siouxland	10	R
Pakistan	Thatta	Bacanora = Kauz's'	0	N/A
Pakistan	Thatta	Cham 8	0	N/A
akistan	Thatta	PBW343 = Attila with Sr31	0	N/A
Pakistan	Thatta	Seri 82	0	N/A
Pakistan	Thatta	Siouxland	0	N/A
akistan	Thatta	Sisson	0	N/A
Pakistan	Thatta	Sr31 (Benno)/6*LMPG-6 DK42	0	N/A

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**Figure 16**. Gene Rank list. Sorted according to Trial site, Disease severity and Infection type. See text for explanation.

#### **Genes Rank Chart**

The Gene Rank Chart is aimed at summarizing effectiveness of all genes tested across all locations into one ranked chart (Fig. 17). Effectiveness is calculated by the system based on user settings identical to the setting options available for the Cultivar Map (Fig. 12) and the Genes Map (Fig 14).

The Genes Rank Chart show the same results as in the Genes Rank list, but now as a graphic tool, aiming at a quick overview of effective / not effective genes, ranked by the number of trial sites where the selected gene is active on all sites tested (Green). When data from more years are included we will develop a chart of results across years for the same location. To explain the method we will look at results from 2012, resistance gene Sr31 (Fig 21), Sr35 (Fig 19) and SrSatu (Fig 20). Sr31 is in 7 different cultivars; SR35 is in RL 6099 (1995) Dyck and SRSatu is in the cultivar Satu.

Sr31 present in:

- 1. Bacanora = Kauz's'
- 2. Cham 8
- 3. PBW343 = Attila with Sr31
- 4. Seri 82
- 5. Siouxland
- 6. Sisson
- 7. Sr31 (Benno)/6\*LMPG-6 DK42

Sr35 present in:

• RL 6099 (1995) Dyck

SrSatu present in:

• Satu



Infected trial map	Cultivar map	Cultivar rank list	Gene map	Gene rank	list (	Gene rank chart			
Ye	ar 🔘 2013 🔍 20	12		Select	trials with	severity on Moroc	co equal to or	higher thar	20 -
Show									
56	elect cultivar with s	everity equal to or lowe	rtnan 20 •	Select	cultivar wi	ith infection type e	qual to or low	erthan 🛛	1К
				Gene rank					
			for	12 trials in 2	012				
	E Re	esistance effective	Resistance not	effective 🛛	No data				
	Sr40 -								
	Sr26 -	- I - I - I			-				
	Sr27 -								
	Sr38 - Sr39 -				-				
	Sr33-								
	SrSatu-								
	Sr11 -			_					
	Sr1RS-Am-							_	
	Sr24 -								
	Sr07a -								
	Sr13-								
	Sr31 -								
	Sr37 -								
	Sr22 -								
	Sr23 -								
\$2	Sr09g -								
ene	Sr15 -								
9	Sr21 -								
	Sr34 -								
	Sr25 -								
	Sr05 -				_				
	Sr07b -								
	Sr09d - Sr18 -				_				
	Sr28 -								
	Sr09a - Sr09a -								
	Sr29 -								
	SrMcN - Sr30 -								
	Sr08b -								
	Sr09b - Sr12 -							-	
	Sr16 -								
	Sr19 - Sr17 -							-	
	Sr20 -								
	Sr10-			į.		1 1			
	U	1 2	3 4	5 Tri	als	/ 8	9 1	υ 1	1 12

**Figure 17**. Gene Rank list. Sorted according to Trial site, Disease severity and Infection type. See text for explanation.

The user select three parameters and then results are generated according to rules given in Fig. 18.

- A: Select trials with severity on Morocco higher than [= 20 % severity]
- B: Select cultivar with severity equal to or lower than [=20 % severity]
- C: Select cultivar with infection type equal to or lower than [MR]

Selecting threshold A reduces the number of relevant trials from 24 to 12, i.e. only in 12 trials, severity on at least one rep of Morocco has severity result that is equal to or higher than 20 %.

General rules (refer to Fig. 18):

- If severity for all reps and for all cultivars with a specific gene tested is indicated as N/A (not applicable), then the result is NO DATA (Grey color).
- If severity is 0 for all cultivars and for all reps with a specific gene tested, then the result is RESISTANCE EFFECTIVE (Green color).
- If severity > threshold B for all cultivars and for all reps with a specific gene tested, then the result is RESISTANCE NOT EFFECTIVE (Orange color)
- If severity ≤ Threshold B then the results is RESISTANCE NOT EFFECTIVE if the results for infection type is <u>higher</u> than threshold C, or, RESISTANCE EFFECTIVE if the results for infection type is <u>equal to or lower than</u> threshold C.





**Figure 18**. Gene Rank List Table. Sorted according to Trial site, Disease severity and Infection type. See text for explanation.

From the Gene Rank Chart in Fig 17, it is indicated that Sr31 is effective at 6 locations and not effective on 6 locations. It is not given on which locations resistance is effective or not. To include this information the user needs the Gene Map, and for detailed information the Gene Rank List.

From the Gene Rank List we can add the results into Gene Rank List tables as given in Fig. 18. These results will correspond with data in the Gene Rank Chart, but now indicating which results/locations are in which class.

	Infection Type [RMS] ≤ Threshold C	Infection Type [RMS] > Threshold C	Infection Type [RMS] = N/A
Severity =N/A			
Severity =0			Sida, EG Thatta, PK
Severity > Threshold B		Nubaria, EG Kelardasht, IR	
Severity ≤ Threshold B	Eldoret, KE Njoro, KE Kunri. PK Greytown, ZA New Halfa, SU Tel Hadya, SY	Gemmeiza, EG Kinamba, KE	

Figure 19. Gene Rank list table for Sr35 in 2012. Threshold B = 20% and Threshold C = MR



	Infection Type [RMS] ≤ Threshold C	Infection Type [RMS] > Threshold C	Infection Type [RMS] = N/A
Severity =N/A			Gemmeiza, EG Nubaria, EG Sida, EG
Severity =0			Eldoret, KE Kinamba, KE Thatta, PK Kunri. PK
Severity > Threshold B			
Severity ≤ Threshold B	Kelardasht, IR Njoro, KE New Halfa, SU Tel Hadva, SX	Greytown, ZA	

Figure 20. Gene Rank list table for SrSatu in 2012. Threshold B = 20% and Threshold C = MR

	Infection Type [RMS] ≤ Threshold C	Infection Type [RMS] > Threshold C	Infection Type [RMS] = N/A
Severity =N/A			
Severity =0			Gemmeiza, EG Thatta, PK Kunri. PK
Severity > Threshold B	New Halfa, SU	Kelardasht, IR Eldoret, KE Kinamba, KE Njoro, KE Greytown, ZA	
Severity ≤ Threshold B	Nubaria, EG Sida, EG Tel Hadya, SY		

Figure 21. Gene Rank list table for Sr31 in 2012. Threshold B = 20% and Threshold C = MR

#### **My Trap Nursery**

During the quality control process it should be possible to compare own results in tables and graphs with similar results in the region. In "My Trap Nursery" tool, the Trap Nursery users can compare own results with results from the same trial site across years and with similar trials in the same year but on other trial locations. Public users will only have access to the overall and general results released by ICARDA and the DRRW project.

#### Input to Pathotype mapper

From the trap nurseries, isolates will be collected and sent to GRRC or a similar lab for pathotyping or genotyping. The results for pathotype/genotype will be included on the Pathotype mapper that is under development.



# **Discussion points**

#### How can we increase the return rate of results?

- Training course (FAO support for training on wheat rust survey, Trap Nurseries and a few more issues).
- Video Training.
- Evaluate and publish the results.
- Include partners in use of the wheat Rust Tolbox via "My Trap Nursery".
- Include results from trap nurseries in RustTracker Country pages.

#### How can we minimize errors and mistakes in the field work?

- Training course
- Update Field Book with training material, documentation etc.
- Quality control of returned data

How to make a final "expert evaluation" of which differentials / genes, mega cultivars and local cultivars that are still active against known virulence genes in the mega population of the stem rust pathogen?

In which form, where, when and whom to deliver the test results? How can we keep the list of differentials, mega cultivars and local cultivars in the Toolbox DB updated – see Annex 1 and Annex 2?

Is it relevant to expand the system to cover Stripe rust Trap Nurseries?

## **Participants**

#### ICARDA

Kumarse Nazari, Senior Cereal Pathologist, ICARDA, is rust pathologist, regional coordinator of International Trap Nurseries.

#### CIMMYT

David Hodson, Senior Scientist at CIMMYT, Ethiopia, main responsible for the BGRI Global Rust Monitoring and Surveillance System / RustTracker

#### Aarhus University

Jens Grønbech Hansen and Poul Lassen, Department of AgroEcology are responsible for the development of the Wheat Rust Toolbox databases and associated tools.

## Literature

Hodson DP, Hansen JG, Lassen P, Alemayehu Y, Arista J, Sonder K, Kosina P, Moncada P, Nazari K, Park RF, Pretorius ZA, Szabo LJ, Fetch T & Jin Y (2012) Tracking the Wheat Rust Pathogen. In: *Proceedings Borlaug Global Rust Initiative 2012 Technical Workshop: Oral Presentations.* McIntosh, R. (red.). bgri@cornell.edu



### **Annex 1. Differentials**

Cultivars	Gene(s)	Origin	Source
07GH	Trident		
94A 236-1 Marquis "B"	Sr19		
94A 237-1 Marquis "C"	Sr20		
Acme CI 5284	Sr09g	Selection from Kubanka (Cl 1516) Pretorius, SA	
Agatha (CI 14048)/9*LMPG-6 DK16	Sr25		
Barleta Benvenuto (Cl 14196)	Sr08b		
Chinese Spring*5/Thatcher 3B	Sr12		
Chinese Spring*7/Marquis 2B	Sr09g	Selection from Kubanka (Cl 1516)	
CI 14167/9*LMPG-6 DK04	Sr08a	Red Egyptian/CS (CI 14167)	
CnsSrTmp	SrTmp	Triumph 64 (CI 13679)/Chinese Spring Jin, USDA	
Eagle Sr26 McIntosh	Sr26		
ER5155 S-203 (1995)Roelfs	Sr28		
Exchange CI 12635	Sr23		
Festiguay W2706 PI 330957	Sr30	Festival / Uruguay C10837	Park, Australia
ISr5-Ra CI 14159	Sr05	Thatcher/Chinese Spring Jin, USDA	
ISr6-Ra CI 14163	Sr06	Red Egyptian/Chinese Spring	
ISr7b-Ra CI 14165	Sr07b	Hope/Chinese Spring	
ISr9a-Ra CI 14169	Sr09a	Red Egyptian/Chinese Spring	
ISr9d-Ra CI 14177	Sr09d	Hope/Chinese Spring	
Kavkaz/Federation4	Sr31	Kavkaz	Pretorius, SA
Kota RL471	Sr28		
LcSr24Ag	Sr24	Little Club/Agent (CI 13523)	
Lee/6*LMPG-6 DK37	Sr11	Lee (Cl 12488)	
Little Club/Sr18Mq Marquis "A"	Sr18		
McNair 701	SrMcN	VA 2001 Increase	
McNair 701 (CI 15288)	SrMcN		Jin, USDA
Mentana W1124 PI 221154	Sr08a	Rieti / Wilhelmina // Akagomughi	Park, Australia
Mq*6//Stewart*3/RL 5244	Sr22		
Na 101/6*Marquis	Sr07a		
Prelude*2/Norka	Sr15		
Prelude*4/2/Marquis*6/Kenya 117A	Sr09b	Kenya 117A	
Prelude*4/2/Marquis*6/Khapstein	Sr13		
Prelude*4/Line W (W3563)	Sr37		
Prelude/8*Marquis*2/2/Esp 518/9	Sr17	Esp 518/9	
Prelude/8*Marquis/2/Etiole de	Sr29		
Choisy			
RL 5405 (1192) Kerber	Sr33		
RL 5711 Kerber	Sr39		
RL 6087 Dyck	Sr40		
RL 6098 (1997) Dyck	Sr34		
RL 6099 (1995) Dyck	Sr35		
Selection from Webster F3:F4 #6	Sr30	Webster Cl 3780	
Sr31 (Benno)/6*LMPG-6 DK42	Sr31	Benno (Sr31)	
T. monococcum/8*LMPG-6 DK13	Sr21	Einkorn CI 2433	Fetch, AAFC
Thatcher/CS (CI 14173)	Sr16		
Trident	Sr38	Spear*4/VPM (PI 519303)	Park, Australia
Trident Sr38	Sr38	08 Aberdean Inc. Source Z. Pretoriuos	
Vernstein PI 442914	Sr09e	Little Club //3* Gabo /2* Charter /3/3* Steinwedel / Cl 7778	
W2691*2/Khapstein	Sr14		
W2691Sr10 Cl 17388	Sr10	Marquis*4/Egypt NA95/2/2*W2691	



## Annex 2. Mega and local cultivars

Cultivars	Gene(s)	Origin	Source
Aguilal		Morocco	
Altar			
Amigo	Sr1RS-Am,Sr24	Hard red winter	
Arrehane		Morocco	
Bacanora = Kauz's'	Sr31		
Bt/Wld	SrWld-1		
Cham 10 = Kauz//Kauz/star		Syria	
Cham 6		Syria	
Cham 8	Sr31		
Chamran = Attila		Iran	
Chris	Sr06,Sr07a,Sr12		
Cook	Sr36		
Coorong (Triticale)	Sr27		
CsSSrTmp	SrTmp	08 Aberdean Inc. Source: 06 AB YJ	
Debeira		Sudan	
Einkorn	Sr21		
EL Nielain		Sudan	
Fleming	Sr06,Sr1RS-Am,Sr24,Sr36	Soft red winter	
Gemmeiza 9		Egypt	
Giza-168		Egypt	
Guard			
Hidhab		Algeria	
Imillo			
Karim			
Kubsa = Attila			
Pavon 76	Sr2 complex		
PBW343 = Attila with Sr31	Sr31		
Roughrider	Sr06,Sr36	Hard red winter	
Satu	SrSatu		
Seri 82	Sr31		
Siouxland	Sr24,Sr31	Hard red winter	
Sisson	Sr06,Sr31,Sr36	Soft red winter	
SrNin	SrNin		
TAM 107	Sr1RS-Am	Hard red winter	
Thatcher			