Surveillance and monitoring the cereal rust diseases in Lebanon, Morocco, and Tunisia in 2022

Plant Health Initiative WP1-OP4

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Summary
Tracking the movement of the wheat rust pathogens and monitoring their pathogenic variabilities are the main pillars in successful breeding for durable rust resistance and disease management programs. Despite the severe drought conditions in wheat growing areas in CWANA in 2022, the rust surveillance was coordinated by the Regional Cereal Rust Research Center-Turkey in Lebanon, Morocco, and Tunisia, following the BGRI rust surveillance protocols. The national rust surveillance teams at the Lebanese Agricultural Research Institute, Institut National de la Recherche Agronomique (Morocco), and INSTITUT NATIONAL DES GRANDES CULTURES-TUNISIA (Tunisia) conducted the rust surveys in target countries. The GPS coordinates of survey sites, the status of rust diseases, and crop phenology were collected and shared with the online Global Cereal Rust Surveillance and Monitoring System (https://rusttracker.cimmyt.org) following the BGRI standard rust surveillance protocol (https://rusttracker.cimmyt.org/wp-content/uploads/2011/11/2013-Updated-BGRI-protocols-v2-web.pdf).

Materials and Methods

Rust surveillance was carried out in farmer's fields and research stations using the BGRI rust surveillance form (https://rusttracker.cimmyt.org/wp-content/uploads/2011/11/2013-Global-Cereal-Rust-Survey-Form-v2.pdf) by national rust survey teams at LARI-Lebanon, INRA-Morocco, and INGC Tunisia. The IPM group of ICARDA in Morocco also conducted the rust survey. Geo-referenced information, crop phenology, disease status during rust severity, and disease incidence were recorded in provided survey forms. Data were shared as excel files with the Global Cereal Rust Monitoring System and RustTracker (https://rusttracker.cimmyt.org).

Results
In total, 31, 41, and eight sited were visited during the rust surveys in Lebanon, Morocco, and Tunisia, respectively. Once possible, rust samples collected and set to RCRRC for race analysis using the RCRRC's rust sampling kit

(results will be presented under PHI-WP1-OP4). Following are received reports about the status of wheat production and wheat rust diseases in Lebanon and Morocco. Tunisian partners just shared the surveillance information. 2021-22 was not favorable for both wheat production and hence rust diseases because of drought and heat stress in almost all wheat growing areas and therefore only a limited number of rust samples were submitted to the RCRRC.

Lebanon

The Status of wheat rusts for the growing season 2021-2022

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Wheat rusts are the most biotic and devastating diseases that affect cereal production in our region. Our region witnessed many recurrent epidemics; there have been several outbreaks since the 1980s of both wheat yellow (stripe) rust, caused by the fungal pathogen Puccinia striiformis f. sp. tritici (Pst) and Puccinia graminis f. sp. tritici (PGT) causing serious economic losses.

Surveillance, monitoring, efficient tracking, and new virulence identification are prerequisites for future race prediction and for effective breeding programs for generating tolerant genotypes.

Surveillance

Surveillance started in the Northern coastal areas where rusts appear yearly and early in the season. Unfortunately, the three rusts did not establish early in April as in previous years as the winter was mild and dry until the emergence of the diseases in May with low incidence and severity. Surveillance was done following the BGRI form. Sampling was done when possible, by detaching the leaves and preserving them in glassine bags. At the end of the day, detached leaves were tapped in order to dry the leaves and avoid leaf rolling; all this was done to avoid germination and increase the spores' viability.

The surveillance was extended to the other part of the country to research stations and to farmers' fields. Unfortunately, we could not find the establishment of rust in farmers 'fields. The climatic conditions were not favorable for rust's establishment: March was snowy and very cold; April was so dry and too hot; the plants were not healthy and could not escape drought and heat waves. About 30 farmers' fields were surveyed across the country but wheat rusts were absent (Excel sheet attached).

At the research station, few samples were collected as supplemental irrigation rescued the situation and the establishment of the rusts in the station was low in severity and incidence. Samples were collected, dried, and shipped via DHL to the Regional Cereal Rust Reference Center (RCRRC)-Izmir by respecting the Turkish laws of the hazardous material transfer agreement.

Trap nurseries (TN)

Monitoring was carried out by planting the trap nurseries distributed by the International Center for Agricultural Research in the Dry Areas (ICARDA) to track the changes in pathogen structure. This was done with two different dates of planting: winter and summer planting. Samples were collected from winter nurseries and shipped with the RCCRRC with the other samples. The summer nurseries had shown low infection of stem and leaf rusts where leaves were dried and kept at 4°C. These TN are very important for the early detection and tracking of new emerging virulent races.

Morocco

The wheat production and the status of wheat rust for the growing season 2021-2022 cropping season in Morocco

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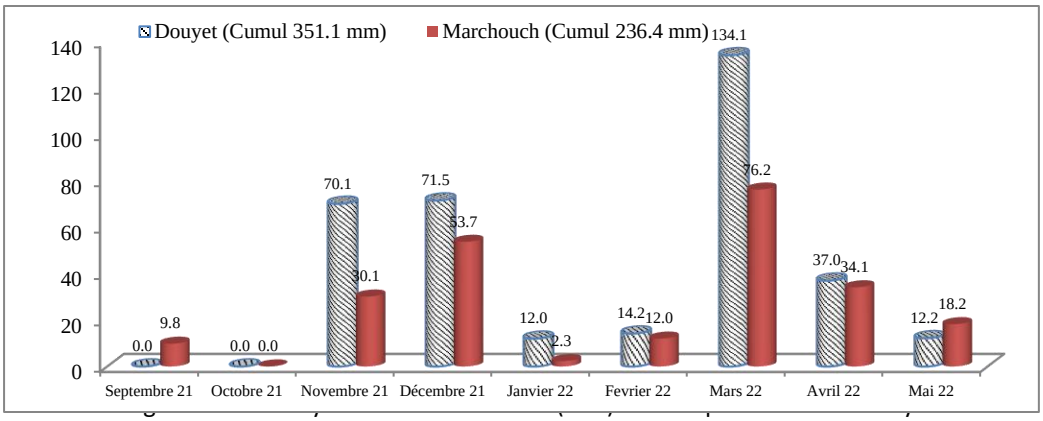
Wheat production

Wheat and barley total harvested area in Morocco during the 2021-2022 cropping season is set to total 3.6 million hectares against 4.35 million hectares during 2020-2021 and 15% less than the five-year average (4.24 million hectares).
The overall production is around 34 million quintals, 67% down from the 2020-2021 season which was 103.2 million quintals.
The total production is partitioned as follows: 18.9, 8.1, and 7.0 million quintals for bread wheat, durum wheat, and barley respectively. Moreover, 58% of the total production came from Fés-Meknès and Rabat-Salé-Kénitra regions, and 20.7% from irrigated areas. In the other cereal growing areas such as Chaouia, Doukkala, and Rhamna, the production had dwindled to almost nothing for two main reasons. Firstly because farmers have been waiting for the 1st precipitations before sowing and secondly farmers that did the sowing and because of the scarcity of rains, fields have been completely destroyed.
The low production was then mainly due to the scarcity of rains since the total rainfall till the end of May 2022 was 199 mm, 44% less than the thirty-year average (303 mm) at the same date.
Moreover, the weather patterns of Douyet (Fés-Meknès) and Marchouch (Rabat-Salé-Kénitra) during the 2021-22 growing season are exhibited in Figure 1. The accumulated rainfall from September 21 to May 22 reached 351.1 and 236.4 mm at Douyet and Marchouch, respectively. The sowing was performed during the 1st fortnight of December at Douyet, Marchouch, and other stations. Rains in December allowed a good crop establishment but the scarcity of rains during January and February (Figure 1) strongly affected the development of the crop. The rains of Marsh, notably at Douyet, allowed a crop recovery to some extent.



at Douyet and Marchouch

On the whole, the season was harsh and wheat experienced harsh conditions mainly during January, February and during April, and May.

Wheat protection

Many wheat nurseries and trials have been tested at different locations in Morocco to evaluate their reaction to diseases notably rusts and to select the best lines to be furthered.
In order to avoid the risk of drought and create conditions for foliar disease development, some nurseries and trials have been carried out at Meknès, where sowing was performed on two dates: 17th December 2021 and 28th January 2022. In addition, one more trial using Faiza, a bread wheat cultivar, was carried out at Meknès and received frequent mist irrigations to boost disease development notably rusts.
For stem rust evaluation, we used a 0 – 5 scale to discriminate between cultivars/lines since the severity of stem rust was not important to use the modified Cobb scale. The used scale is described below (Table 1).

Table 1. Evaluation of the reaction of wheat to Stem Rust

Score	Reaction to stem rust
0	Immune
1	Resistant
2	Moderately resistant
3	Moderately susceptible
4	Susceptible
5	Highly susceptible

As said before, the scarcity of rains coupled with heat stresses did not allow foliar disease development except for some pustules of stem rust observed on field trials at INRA experimental stations.

It is to notice the high severity of stem rust (60 S) on Faiza, a bread wheat cultivar that is widely adopted by farmers, at Meknès. This trial was naturally infested and received frequent mist irrigations. This means that stem rust is a potential threat to wheat production in Morocco that is exacerbated by the fact that none of neither bread wheat nor durum wheat commercial cultivars exhibited immunity towards this disease (Table 3)
The evaluation of the 135 bread wheat entries of the *16-STEMRRSN* under Meknès conditions revealed that none of them was immune to Stem rust and 59% of them exhibited a good level of resistance (Table 3). None of them exhibited high susceptibility to stem rust.

Table 3. Reaction to stem rust of Bread wheat and Durum wheat cultivars and lines of 16th STEMRRSN, under Meknès conditions during the 2021-2022 cropping season

Scale	Number of entries of BW and %		Number of entries of DW and %		Number of entries of 16th STEMRRSN and %	
	Stem rust	%	Stem rust	%	Stem rust	%
Immune	0	0	0	0	0	0
1	8	29	8	29	80	59
2	4	14	10	37	39	29
3	10	36	8	30	13	10
4	5	18	1	4	3	2
5	1	4	0	0	0	0
Total	28	100	27	100	135	100

BW, DW, and 16th STEMRRSN stand for Bread wheat, Durum wheat, and 16th Stem Rust Resistance Screening Nursery, respectively.

Conclusion

The erratic rainfall and heat patterns in Morocco should trigger the implementation of the wheat research program, notably the breeding one, to yield new wheat cultivars that are more resilient and suitable for such conditions.
When the cropping seasons are rainy and cool which is appropriate for good production, wheat experiences the biotic constraints that hinder production. Conversely, when the season is dry, wheat faces rather a scarcity of available water coupled with heat stresses.
So, as long as we do not have yet a regionalized registration catalog, breeding for wide adaptation is mandatory. That is to say, breeders should focus on wheat cultivars that are at the same time tolerant to drought and heat but also resistant/tolerant to the main prevalent biotic constraints notably Hessian fly, Septoria, and Rusts.


Stem rust on Faiza (BW) at Meknès (Photo: May 31st, 2022)