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Review Article

First Report of *Puccinia striiformis* F. Sp. *Tritici* Race ME2018 in Irrigated Wheat Production in Ethiopia

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Abstract

Stripe rust, caused by *Puccinia striiformis* f. sp. *tritici*, is a devastating disease of wheat in Ethiopia and the globe. The disease was dynamic and quite complex with the host (variety and plant spp), the environment, and with the pathogen genetic nature. The genetic alternation or change of a pathogen could affect the resistant population in the area. New race identification helps preparedness for the needs a rise to reduce the possible losses due to the problem. The race analysis dynamics identified three yellow rust races; namely, PstS11, PstS16 and ME2018 and one other unknown new race were the major in recent years but in the 2012-2016 Psts1 and PSTS2 were the dominant once. The new race ME2018 race mixture was increased the risk of stripe race epidemics in the area because it is Yr10-virulence race. So regular monitoring, for early detection and identification of new races was crucial.

Keywords: Dynamic, Genetic, Preparedness, Identification, ME2018, and epidemics.

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SHORT SUMMARY OF RESULTS

Stripe rust, caused by *Puccinia striiformis* f. sp. *tritici*, is a devastating disease of wheat in Ethiopia and worldwide. Yield losses caused by stripe rust in Ethiopia have ranged from 40 to 100% depending on the degree of susceptibility of cultivars, time of initial infection and environmental conditions during epidemic development (Badebo *et al*., 2001). Ethiopia experienced one of the most serious stripe rust epidemics in 2010, with more than 600,000 ha of wheat affected and an estimated $US 3.2 million spent on fungicides (Abeyo *et al*., 2014). Epidemics of yellow rust have become more frequent and widespread at higher altitudes in south eastern Ethiopia due to variety susceptibility and favorable weather conditions. Arsi and Bale highlands in south eastern Ethiopia are the major common (bread) wheat producing provinces and are considered the wheat belts of East Africa. Bale zone alone contributes about 11% of the country‘s wheat production (FDRE, Federal Democratic Republic of Ethiopia, 2002). The Arsi and Bale highlands are also a hot spot in the army race for Triticum Puccinia system (Mulugeta *et al.*, 1986). It is an economic disease of wheat (*Triticum aestivum* L.) in the highlands of Ethiopia with altitude ranging from 2150 to 2850 m above sea level (Mengistu *et al*., 1991) and from 2000- 2850 in the cool season production using irrigation. Disease epidemic intensity was linked to the number of rainy days, the number of days with minimum temperatures within the range of 7−8°C and relative humidity (RH) above 60%, and the number of periods involving consecutive days with minimum temperature within the range of 6−9°C and RH% > 60% during a 240-day period (Naseri and Sharifi, 2019). In Ethiopia it was reported that the optimum (11°C) for stripe rust epidemic development (Bekele *et al*., 2002).

Races of the aggressive strain (likely PstS2) were also in 2014 common across many sampling areas in East Africa and Asia. So far isolates of PstS2 always share virulence to Yr2, Yr6, Yr7, Yr8 and Yr9, often being combined with virulence to Yr27. PstS2 was detected frequently in Ethiopia, Kenya, Tanzania and Rwanda, often with additional virulence to Yr1 or Yr10. Another group of Yr27-virulent races were observed in East Africa, e.g., Rwanda and Ethiopia, where it was

often detected during the big epidemics in east Africa in 2010. Thus, the combination of virulence for Yr27 and aggressiveness has proven to increase the epidemic risks in many areas (Hovmøller *et al*., 2015).

During 2021/22 irrigated cropping season (October – March), wheat rust surveys were undertaken in major irrigated wheat growing regions of Ethiopia, and yellow rust was recorded in 46 (46.46%) of the 99 wheat fields surveyed. The race analysis was undertaken at Global Rust Reference Center **(***GRRC) in* Aarhus University, Denmark. The analysis identified three yellow rust races; namely, PstS11, PstS16 and ME2018 and one other unknown new race (Fig. 1). Of these, ME2018 and one other unknown new races was detected for the first time in Ethiopia. The race PstS11 was virulent to Yr -,2, -, (4), -,6,7,8, -, -, -,17, -, -,27,32, -, AvS, -; While PstS16 was virulent to Yr 1,2,3, (4), -,6,7,8,9, -, -,17, -,25,27,32, -, Avs, -; and the new confirmed race ME208 was virulent to Yr -,2, -, (4), -,6,7,8, -, -, -,17, -, -, -,32, -, AvS, Amb. The ME2018 race is also virulent against Yr10/ Yr24. This requires further investigation but it has been confirmed that it is virulent on durum wheat varieties. This race was identified from samples collected from Samora Seqo area in Dendii district, West Shwea Zone, Oromia Region, Ethiopia (Fig. 2). Race ME2018 was identified from samples collected to unknown commercial wheat variety.

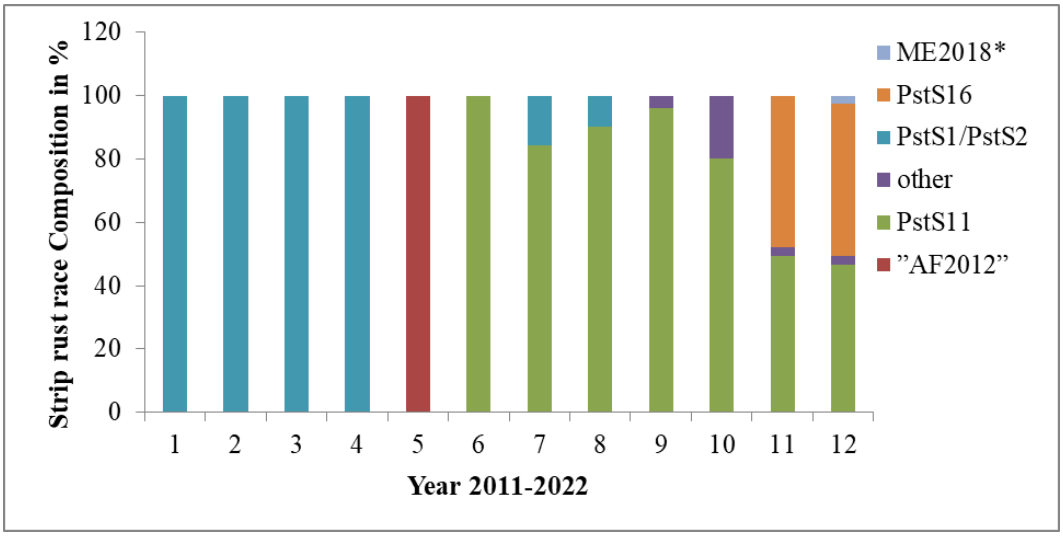

Figure 1: The past 12 year wheat strip rust race dynamics in Ethiopia (GRRC, 2011-2022).

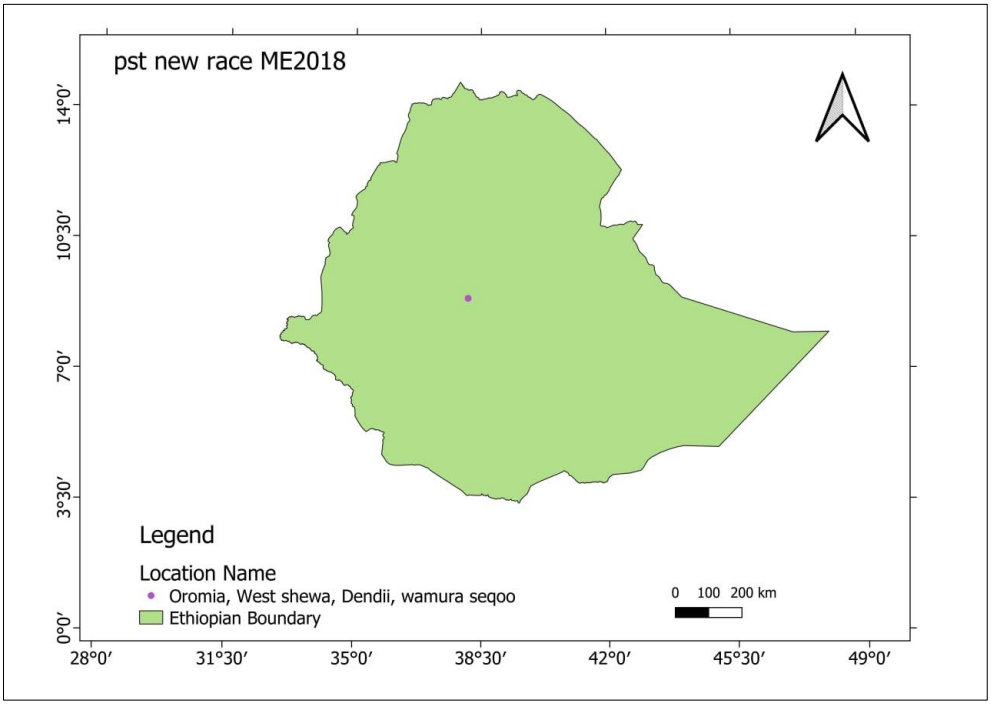

Figure 2: Geographical location of Pgt race ME2018 in Ethiopia in 2018

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Pst11, first detected in Central Asia in 2012, became the most prevalent genetic group of yellow rust in East Africa in 2018, detected in Ethiopia (2016 first detected), Kenya, Rwanda and Tanzania. The recent inter-continental spread into East Africa was confirmed by the presence of only a single race in group PstS11 irrespective of sample origin. PstS11 is now confirmed in six countries in Africa and the Middle East, i.e., Ethiopia, Kenya, Rwanda, Tanzania, Uganda and Turkey. PstS11 was first detected in Afghanistan (2012) after which it spread to neighboring countries. So far, only a single race has been confirmed in PstS11 (virulence phenotype: -,2,-,4,-,6,7,8,-,-,-,17,-,-,27,32,-,AvS,-). The virulence of a representative set of recent PstS11 isolates from Turkey and East Africa is being investigated at present time. The rapid spread across wide areas, and associated rust epidemics, including previously resistant varieties in affected areas, demonstrate the potential risks associated with this race/genotype, and evolution of additional virulence can be expected. A new genotype in the Middle East (provisionally termed ME2018), first detected in dead samples from Egypt (2018), was observed in 2019 at several locations in Turkey (Hovmøller, 2020) and found in 2022 samples from Ethiopia. The race is virulent to the durum wheat as well as bread wheat. Close monitoring of the race phenotype is ongoing and vital.

PstS11 (Sharma-Poudyal *et al*., 2013) studied an international *Pst* collection including 53 isolates from Turkey and determined that most of the isolates from Turkey were virulent on at least 11 resistance genes with very high frequency (>70%) and avirulent on *Yr5, Yr10* and *Yr15*. (Hovmøller *et al*., 2020) reported that a race belonging to the PstS11 lineage first detected in Afghanistan in 2012 was found in six African countries and the Middle East including Ethiopia, Kenya, Rwanda, Tanzania, Uganda and Turkey, and had the virulence formula: *Yr2, Yr4, Yr6, Yr7, Yr8, Yr17, Yr27, Yr32, AvS*. In addition, the race 'Triticale2015′ (virulence formula: *Yr2, Yr6, Yr7, Yr8, Yr9, AvS*) and a race belonging to the PstS14 lineage (virulence formula: *Yr2, Yr3, Yr6, Yr7, Yr8, Yr9, Yr17, Yr25, Yr32, YrSp* and *AvS*) were recorded in Turkey in 2019 (Hovmøller *et al*., 2020).

PstS16 A new incursion of a highly virulent race in East Africa represented a new genetic group, termed PstS16.It was detected in December 2020 in Ethiopia and became widespread in farmer's fields and experimental plots in 2021, but not detected in neighboring countries. PstS16 was also widespread in Afghanistan in 2021(Hovmøller *et al*., 2022).

ME2018 A new genotype in the Middle East (provisionally termed ME2018, 'Other' on the map), first detected in dead samples from Egypt (2018), and at several locations in Turkey (2019), was detected for the first time in Europe, Latvia (2020). This observation was confirmed by independent assays of incoming infected leaves, race typing of recovered isolates, and re-submission of additional samples from the sampling area. Two races differentiated by Yr10-virulence were detected within ME2018 (Hovmøller *et al*., 2021), first detected in Egypt (2018) and provisionally termed ME2018, was observed on both bread wheat and durum wheat in Turkey (Hovmøller *et al*., 2020).

The current result strengthens the importance of regular monitoring, for early detection and identification of new races. The utilization of this information was vital in screening and identification of effective sources of resistance genes. Moreover, the result highlighted the need for developing cultivars with combinations of effective resistance genes to enhance their longevity. Alternatively, cultivars with multiple minor genes to achieve durable resistance could be developed. Further spread of the new race ME2018 is considered likely and requires close monitoring.

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