

Characterization of *Puccinia graminis* f. sp. *tritici* isolates from collections from Georgia in 2017-2020

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INTRODUCTION

Wheat stem rust, caused by *Puccinia graminis* f. sp. *tritici* (Pgt) is a common disease in Georgia. Analysis of stem rust samples collected from 2013–2015 indicated that Georgia is a hotspot for phenotypic and genotypic diversity, and that virulence to important resistance genes including *Sr13b*, *Sr22*, *Sr24*, *Sr35*, *Sr37*, *Sr50*, were detected in the Pgt populations. We continue to monitor this population due to presence of an active sexual cycle of the pathogen, likely the origin of the highly virulent Pgt races TTRTF and TKKTF which have spread to other parts of the world.

MATERIALS and METHODS

- Samples collection:** 122 wheat stem rust samples were collected in 2017-2020 wheat growing seasons from farmer fields and wheat nurseries.
- Race analysis:** Single-pustule isolates were race typed based on 20 North American differential set and further characterized on additional monogenic lines carrying important stem rust resistance genes.
- Genotyping:** A set of 52 representative isolates were genotyped using the Pgt Core SNP assay consisting of 17 markers.

RESULTS and DISCUSSION

1) Race analysis

Twelve races were identified from 160 single pustule isolates. Race TKKTF was predominant, being the only race detected in all four growing seasons. Races TKFTF and TTRTF were observed in three seasons.

Table 1. Year and number of isolates of identified *Pgt* races in 2017-2020 wheat growing seasons in Georgia.

	2017	2018	2019	2020
TKFTF		9	8	
TKFTF + <i>Sr35</i>		1		
TKFTF + <i>Sr35</i> + <i>Sr47</i>	13	3		
TKKTF	6	13	19	5
TKKTF + <i>Sr1RS^{Amigo}</i>		2	3	1
TTRTF	1	3	2	2
PKPTF		3		
TKPTF		1		
TKPTC	1			
TKTTF			1	
MRCTD			1	
MRCTF			1	

Although races TKKTF and TKFTF were also detected in 2014 and 2015 seasons, the isolates from the 2017-2020 samples have additional virulences not observed before. In 2017, virulence on *Sr47* was detected in isolates of race TKFTF, whereas virulence on *Sr1RS^{Amigo}* was identified in isolates of race TKKTF in 2018 (Fig. 1). Races MRCTD and MRCTF exhibited a unique virulence combination that resemble the races from sexual origin identified in 2013.

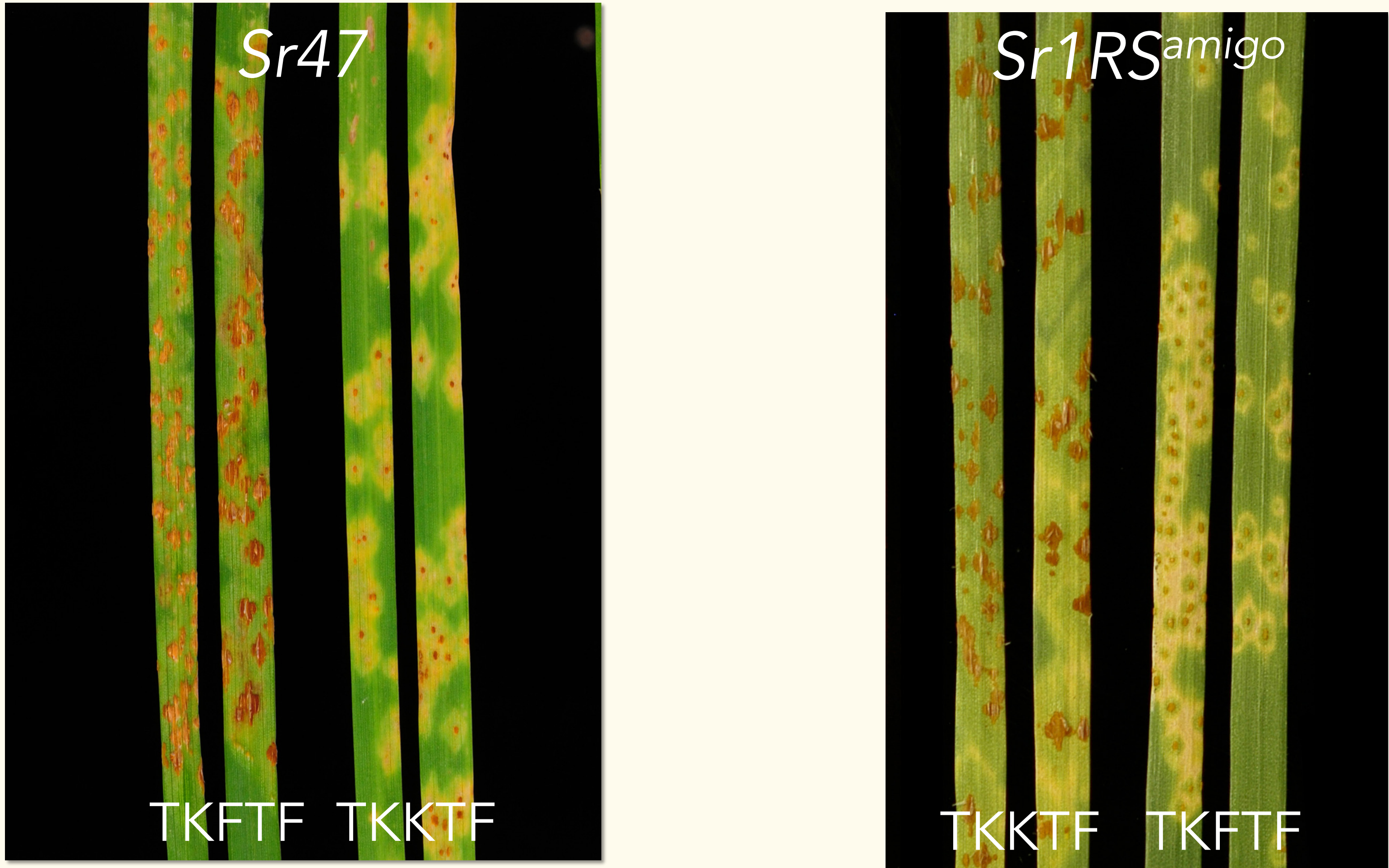


Figure 1. Infection types on lines carrying *Sr47* and *Sr1RS^{Amigo}* caused by races TKKTF and TKFTF.

2) Genotyping

Most of the genotypes obtained were of clades III (race TTRTF) and IV (races TKFTF, TKKTF, TKPTC, TKTTF), corresponding to the genotypes of the isolates from 2014 and 2015 seasons. Isolates of race MRCTD and MRCTF had a new genotype. These results indicate that the Pgt population in Georgia is dynamic and generating Pgt strains with new virulence phenotype through sexual recombination and mutation.

Table 2. Core SNP assay genotypes of selected isolates derived from stem rust samples collected in Georgia in 2017 and 2019.

ISOLATE	YEAR	RACE	Clade	MLG	Core SNP Assay																
					A101	A105	A106	A107	A109	A111	A119	A121	A126	A127	A128	A129	A130	A131	A133	A134	A135
17GEO217	2017	TTRTF	III-B	Co-A04	CA	CT	TG	CC	CC	GG	CC	AA	AA	AA	GG	CC	TC	GG	GG	CA	CC
17GEO216	2017	TKPTC	IV-C	Co-A08	CA	CT	TG	TC	GC	AG	TT	AG	GG	AA	CG	TC	TT	GA	GG	CC	CC
19GEO291-1	2019	TKFTF	IV-E.1	Co-A10	AA	CC	TT	TC	CC	AG	TC	AA	GA	GA	GG	CC	TC	GA	GG	CC	CT
19GEO308-1	2019	TKFTF	IV-E.1	Co-A10	AA	CC	TT	TC	CC	AG	TC	AA	GA	GA	GG	CC	TC	GA	GG	CC	CT
19GEO302-4	2019	TKKTF+1RS ^{Amigo}	IV-E.1	Co-A10	AA	CC	TT	TC	CC	AG	TC	AA	GA	GA	GG	CC	TC	GA	GG	CC	CT
19GEO304-1	2019	TKKTF+1RS ^{Amigo}	IV-E.1	Co-A10	AA	CC	TT	TC	CC	AG	TC	AA	GA	GA	GG	CC	TC	GA	GG	CC	CT
17GEO212	2017	TKFTF+35+47	IV-E.2	Co-A11	AA	CT	TG	TC	CC	AG	TC	AA	GA	AA	CG	CC	TC	AA	GG	CA	CT
17GEO222	2017	TKFTF+35+47	IV-E.2	Co-A11	AA	CT	TG	TC	CC	AG	TC	AA	GA	AA	CG	CC	TC	AA	GG	CA	CT
17GEO229	2017	TKFTF+35+47	IV-F	Co-A14	CC	CT	TG	TC	CC	GG	TC	AG	GA	AA	CG	TC	TC	GA	GG	CC	CT
17GEO213	2017	TKKTF	IV-F	Co-A14	CC	CT	TG	TC	CC	GG	TC	AG	GA	AA	CG	TC	TC	GA	GG	CC	CT
19GEO288-1	2019	TKFTF	IV-F	Co-A14	CC	CT	TG	TC	CC	GG	TC	AG	GA	AA	CG	TC	TC	GA	GG	CC	CT
19GEO297-1	2019	TKKTF	IV-F	Co-A14	CC	CT	TG	TC	CC	GG	TC	AG	GA	AA	CG	TC	TC	GA	GG	CC	CT
19GEO293-1	2019	TKTTF	IV-F	Co-A14	CC	CT	TG	TC	CC	GG	TC	AG	GA	AA	CG	TC	TC	GA	GG	CC	CT
19GEO301-1	2019	MRCTD	N/A	New	CA	TT	TG	CC	GC	AA	CC	GG	GG	AA	GG	TC	TT	GA	GG	CC	CT
19GEO302-1	2019	MRCTF	N/A	New	CA	TT	TG	CC	GC	AA	CC	GG	GG	AA	GG	TC	TT	GA	GG	CC	CT

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