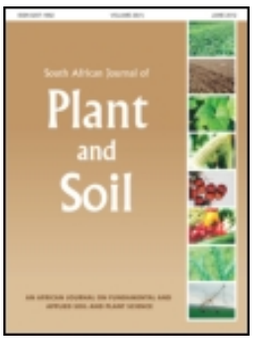

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Occurrence and pathogenicity of *Puccinia triticina* on wheat in South Africa during 2007

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A survey was conducted during 2007 to determine the occurrence and pathogenicity of *Puccinia triticina* Eriks., the cause of wheat leaf rust, in South Africa. Leaf rust was widely observed in the wheat growing areas of the Western Cape but only at a few localities in the Free State. A low incidence of leaf rust was detected at Cedara (KwaZulu-Natal). Leaf rust widely occurred within trap nurseries but it was observed only occasionally in farmers' fields. Five pathotypes were identified from the total of 80 leaf rust samples collected. The most frequently detected pathotype was 3SA133 (76.8%) which was found in samples from all the localities followed by pathotype 3SA126 (11.0%). Other pathotypes detected were 3SA140 (7.3%), 3SA132 (3.7%) and 3SA137 (1.2%). None of the isolates tested was virulent on the resistance genes *Lr3bg* and *Lr16* with the majority of the isolates (>73%) found virulent on the resistance genes *Lr3a*, *3ka*, *11*, *20*, *24* and *30*. No isolates avirulent on *Lr1*, *2c*, *10* and *14a* were found. The virulence patterns of pathotypes detected in 2007 was similar to those observed in previous seasons and new pathotypes were not observed. Thus, a significant change in the response of current commercial cultivars is not expected considering the results.

Keywords: Leaf rust, pathotype, *Puccinia triticina*

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Leaf rust caused by *Puccinia triticina* Eriks. is one of the most important diseases of wheat (*Triticum aestivum* L.) worldwide. In South Africa, the disease occurs in many of the wheat growing areas and impacts negatively on production by lowering yield and quality of the crop. Wheat production in the winter rainfall regions of the Western Cape and in areas with moist and hot spring conditions in the Free State are frequently affected by leaf rust (Pretorius *et al.*, 1987; Pretorius & Le Roux, 1988, Pretorius *et al*., 2007).

Incidence and severity of leaf rust can be significantly reduced by timely and accurate application of fungicides (Dannenberg *et al.*, 1989). However, fungicides are expensive and their incorrect and repeated use can harm the environment. Thus, worldwide research focuses on finding sources of resistance for the control of leaf rust (Marias *et al.*, 2006; Joshi *et al.*, 2007). Although resistance can provide effective control, new pathotypes of the leaf rust pathogen may develop and attack cultivars that were previously resistant. The appearance of virulent pathotypes has resulted in severe leaf rust epidemics in many wheat production areas of the world including South Africa (Pretorius *et al.*, 1990; McCallum & Seto-Goh, 2005). Thus, it is important to constantly monitor changes in the leaf rust pathogen population in order to determine the frequencies of existing pathotypes and to detect new pathotypes when they occur. This information is important for breeding effective and sustainable resistant cultivars. Locally, virulence of the leaf rust pathogen has been monitored annually since the early 1980s (Pretorius & Le Roux, 1988; Agricultural Research Council-Small Grain Institute (ARC-SGI), unpublished data; Terefe, 2007). The main objective of this survey was to determine the frequency and distribution of *P. triticina* pathotypes in South Africa during 2007.

The occurrence and distribution of wheat leaf rust was determined through surveillance of commercial fields and of rust trap nurseries planted in the major wheat production areas. Traps nurseries were planted at different localities in the Free State and the Western Cape as well as at Cedara (KwaZulu-Natal) and Nelspruit (Mpumalanga). In a neighbouring country Lesotho, wheat is commonly planted at the end of the wheat growing season in South Africa. Therefore, this region is presumed to be a possible over-summering zone and source of inoculum for wheat rusts in South Africa. Thus, one trap nursery was also planted at Mokhotlong in Lesotho to monitor the virulence pattern of *P. triticina* occurring in that locality. The trap nurseries consisted of several lines with combinations of different leaf rust and stem rust resistance genes, commercial wheat cultivars, advanced breeding lines and leaf rust differentials. A cultivar highly susceptible to leaf rust (Morocco) was also included as a trap line. The trap nurseries planted at Cedara, Mokhotlong and in the Free State had 181 entries whereas those planted in the Western Cape had between 64 and 143 entries. Trap nurseries were planted at 12 localities in the Free State and at 10 localities in the Western Cape.

All trap nurseries were monitored for occurrence of leaf rust from August to December 2007. The site in Lesotho was surveyed three times during March and April 2008. The prevalence of leaf rust in the major wheat growing areas was estimated by determining the trap localities that showed leaf rust infection as percentage of the total number of trap localities observed (Ngugi *et al.*, 2002).

Wheat leaves infected with leaf rust were collected from trap nurseries and farmers' fields. The samples were put in glassine bags and transported to ARC-SGI. Urediniospores were collected from each sample using a cyclone spore collector. A spore suspension prepared in a mineral oil (Soltrol-170) was inoculated directly onto a differential set of Thatcher near isogenic lines [RL6003 (*Lr1*), RL6016 (*Lr2a*), RL6019 (*Lr2b*), RL6047 (*Lr2c*), RL6002 (*Lr3a*), RL6042 (*Lr3bg*), RL6007 (*Lr3ka*), RL6004 (*Lr10*), RL6053 (*Lr11*), RL6013 (*Lr14a*), RL6052 (*Lr15*), RL6005 (*Lr16*), RL6008 (*Lr17*), RL6064 (*Lr24*), RL6078 (*Lr26*), PL6049 (*Lr30*)] and Thew (*Lr20*).

The seeds of the differential set were sown in plastic pots (10 cm diameter) filled with steam-sterilised soil. Prior to planting, the soil was treated with water soluble fertilizer (10 g L^{-1}) containing nitrogen (15%), phosphorous (4.5%) and potassium (26.3%). Seedlings were also fertilised with a suspension of limestone ammonium nitrate (LAN) (10 g L^{-1}) one day before inoculation. Seven days after planting (first leaf fully extended), seedlings were spray-inoculated with urediniospore suspensions using an atomiser. An enclosed inocu-

lating chamber, washed with water between inoculation of each isolate, was used to eliminate contamination. After drying for two hours in an air-conditioned room, inoculated seedlings were placed in a dew chamber at 20 ± 2°C and 100% relative humidity for approximately 18 hours. Seedlings were then removed from the dew chamber, allowed to dry for two hours and moved to a glasshouse cubicle with temperature of *circa* 20°C. In addition to exposure to daylight, plants received supplemental photosynthetically active radiation (10 000 lux) emitted by cool white fluorescent tubes hanging directly from above them (14 h day^{-1}). Ten to fourteen days after inoculation, plants were assessed for disease response (infection type) using a 0-4 scale (Roelfs *et al.*, 1992). Infection types 0-2 were considered low and infection types 3-4 were considered to be high. Isolates producing low infection type were regarded as avirulent and those giving high infection type were considered to be virulent.

During the 2007 season, leaf rust was widely distributed throughout the wheat growing areas of the Western Cape. This disease occurred at most of the trap nursery sites in the South Western parts of the Western Cape known as the Rûens (80%) and the Western parts of the Western Cape known as the Swartland (50%). Overall, 70% of the trap nursery sites in the Western Cape showed varying levels of leaf rust infection. At some sites, leaf rust severities of as high as 90% was recorded on cultivar Morocco. However, only a small percentage of the trap nursery sites (10%) surveyed in the Free State indicated the presence of leaf rust (Figure 1). Generally, the incidence of leaf rust in the Free State was lower than that of the Western Cape as also recorded in 2006 and previous seasons (Terefe, 2007; ARC-SGI, unpublished data). This is partly attributed to relatively dry weather in the Free State during the growing season. Leaf rust was detected also at Cedara (KwaZulu-Natal) and Mokhotlong (Lesotho) but with a relatively lower incidence than in the Western Cape. No leaf rust was observed on the traps planted at Nelspruit (Mpumalanga). Although leaf rust was observed widely on lines planted within the trap nurseries at many localities, its incidence in farmers' fields was generally lower possibly due to application of fungicides or to the planting of resistant cultivars.

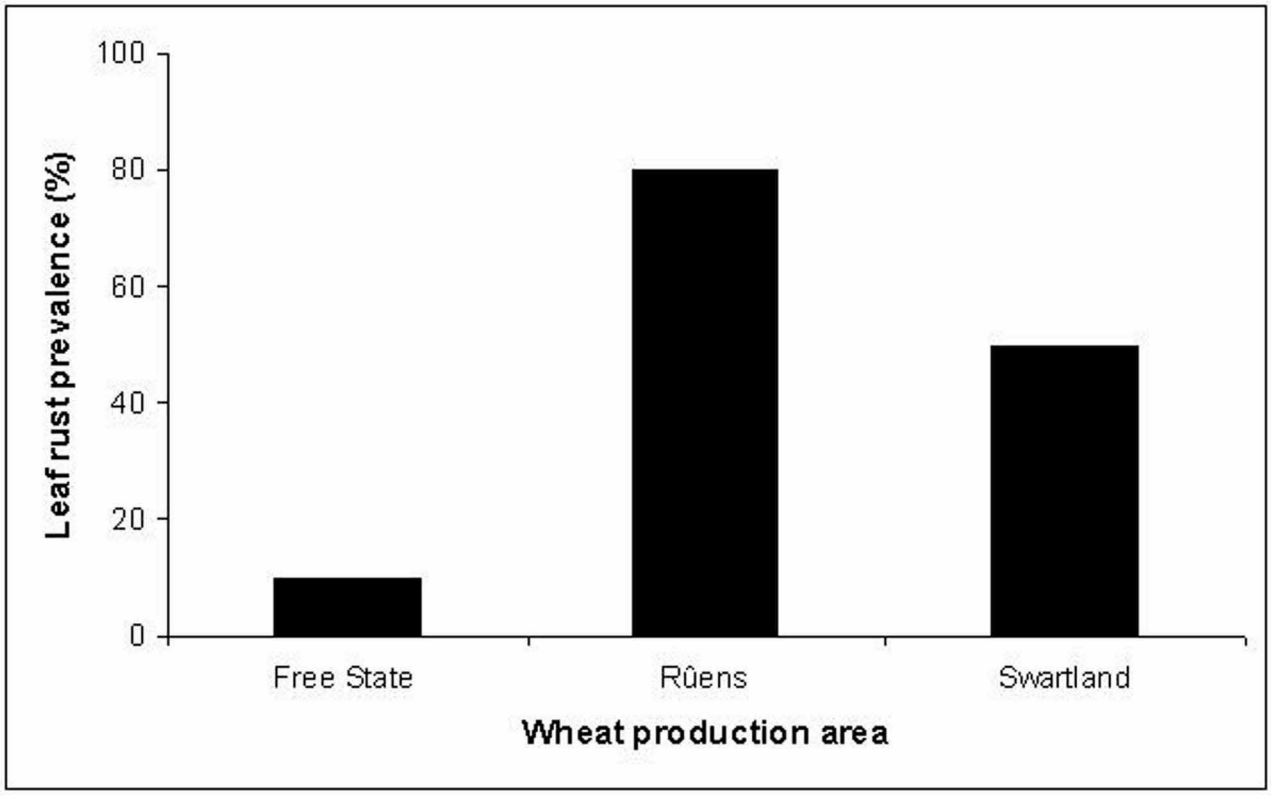

Figure 1 Prevalence of leaf rust in the major wheat growing areas of South Africa namely the Free State and the Western Cape during 2007. The Rûens and Swartland are located in the South Western and Western parts of Western Cape, respectively

A total of 80 leaf rust samples were collected during the 2007 cropping season; and 82 isolates obtained from these samples were successfully pathotyped. Most of these isolates originated from infected leaves sampled in the Western Cape whereas some were isolated from samples taken from the Free State, Cedara and Mokhotlong. Five pathotypes were identified. The most frequently observed pathotype, 76.8% of the isolates, was 3SA133 (avirulence/virulence formula: *Lr2a*, *2b*, *3bg*, *15*, *16*, *17*, *26*/*1*, *2c*, *3a*, *3ka*, *10*, *11*, *14a*, *20*, *24*, *30*) (Table 1). This pathotype was detected in samples collected from all the localities. Pathotype 3SA126 (avirulence/virulence formula: *Lr3a*, *3bg*, *3ka*, *11*, *16*, *20*, *24*, *26*, *30*/*1*, *2a*, *2b*, *2c*, *10*, *14a*, *15*, *17*) was second in frequency (11.0%). It was recovered from samples collected in

the Rûens, the Swartland, the Free State and Mokhotlong (Lesotho) but not from Cedara (KwaZulu Natal). Pathotype 3SA140 (avirulence/virulence formula: *Lr3a*, *3bg*, *3ka*, *11*, *16*, *20*, *30*/*1*, *2a*, *2b*, *2c*, *10*, *14a*, *15*, *17*, *24*, *26*) comprised 7.3% of the isolates whereas 3SA132 (avirulence/virulence formula: *Lr3a*, *3bg*, *3ka*, *11*, *16*, *20*, *26*, *30*/*1*, *2a*, *2b*, *2c*, *10*, *14a*, *15*, *17*, *24*) and 3SA137 (avirulence/virulence formula: *Lr3a*, *3bg*, *3ka*, *11*, *16*, *20*, *24*, *30*/*1*, *2a*, *2b*, *2c*, *10*, *14a*, *15*, *17*, *26*) were detected only from 3.7 and 1.2% of the isolates, respectively.

Table 1 Avirulence and virulence of *Puccinia triticina* isolates collected from different localities in South Africa during 2007 and Lesotho during 2008

Avirulence/virulence formula	Western Cape			Free-State	KwaZulu-Natal	Lesotho			
	Swartland	Rûens	Stellenbosch		Cedara	Mokhotlong	Total	Frequency (%)	Pathotype
2a, 2b, 3bg, 15, 16, 17, 26/1, 2c, 3a, 3ka, 10, 11, 14a, 20, 24, 30	22	25	2	2	5	7	63	76.8	3SA133
3a, 3bg, 3ka, 11, 16, 20, 24, 26, 30/1, 2a, 2b, 2c, 10, 14a, 15, 17	1	1	0	6	0	1	9	11.0	3SA126
3a, 3bg, 3ka, 11, 16, 20, 30/1, 2a, 2b, 2c, 10, 14a, 15, 17, 24, 26	3	1	0	0	1	1	6	7.3	3SA140
3a, 3bg, 3ka, 11, 16, 20, 26, 30/1, 2a, 2b, 2c, 10, 14a, 15, 17, 24	1	2	0	0	0	0	3	3.7	3SA132
3a, 3bg, 3ka, 11, 16, 20, 24, 30/1, 2a, 2b, 2c, 10, 14a, 15, 17, 26	1	0	0	0	0	0	1	1.2	3SA137
Total	28	29	2	8	6	9	82		

Pathotype 3SA133 started dominating the leaf rust pathotype spectrum during the late 1980s and was a major component of pathotypes identified during 1986-1988 (Pretorius & Le Roux, 1988; Pretorius *et al.*, 1990). The prevalence of this pathotype gradually decreased for a few years following 1988 only to become one of the most dominant leaf rust pathotypes from 1997 onwards (ARC-SGI, unpublished data; Terefe, 2007). According to some reports, the buildup of 3SA133 was associated with widespread use of susceptible cultivars like Kariega, SST 57 and Gariep (Van Niekerk & Boshoff, 1999). These cultivars are all susceptible to 3SA133, but some of them are resistant to stripe rust (*Puccinia striiformis* Westend.) and hence they have been grown widely since stripe rust was first observed in South Africa in 1996.

Pathotype 3SA126 was identified from the majority (75%) of the samples collected from the Free State (Table 1). This pathotype has been reported frequently from the Free State and other provinces since the early 1980s and was dominant during 1988 and 2000 (ARC-SGI, unpublished data; Pretorius *et al.*, 1990)

Other pathotypes detected during the 2007 survey were 3SA140, 3SA132 and 3SA137 (Table 1). Pathotype 3SA140 dominated during 1989-1993 and since 1994, it has been encountered regularly but at a lower frequency (Van Niekerk & Boshoff, 1999; Terefe, 2007). Pathotype 3SA137 was identified for the first time in 1988 and was subsequently detected in the 2000 and 2004 seasons (ARC-SGI, unpublished data; Pretorius *et al.*, 1990).

All of the isolates were virulent on the leaf rust resistance genes *Lr1*, *2c*, *10* and *14a*. Most were also virulent on *Lr3a*, *3ka*, *11*, *20*, *24* and *30* (Table 1; Figure 2). Virulence on many of these genes is common in many wheat growing areas of the world (McIntosh *et al.*, 1995; McCallum & Seto-Goh, 2005; Kolmer *et al.*, 2006).

Leaf rust resistance genes *Lr2a*, *2b*, *15*, *17* and *26* were effective against more than 75% of the isolates (Table 1; Figure 2) mainly due to their resistance to 3SA133 which was the predominant pathotype. All these five genes were ineffective against the remaining two or more pathotypes. No isolate was virulent on *Lr3bg* and *Lr16* indicating that these genes are effective against current South African pathotypes.

Since leaf rust commonly occurred within the trap nurseries rather than in farmers' fields, it appears that the disease is under control through the use of fungicides and resistant cultivars and is not presently a serious threat to wheat production in South Africa. The virulence pattern of leaf rust pathotypes detected in 2007 was generally similar to those observed in previous seasons. Thus, a significant change in the response of current commercial cultivars may not be expected.

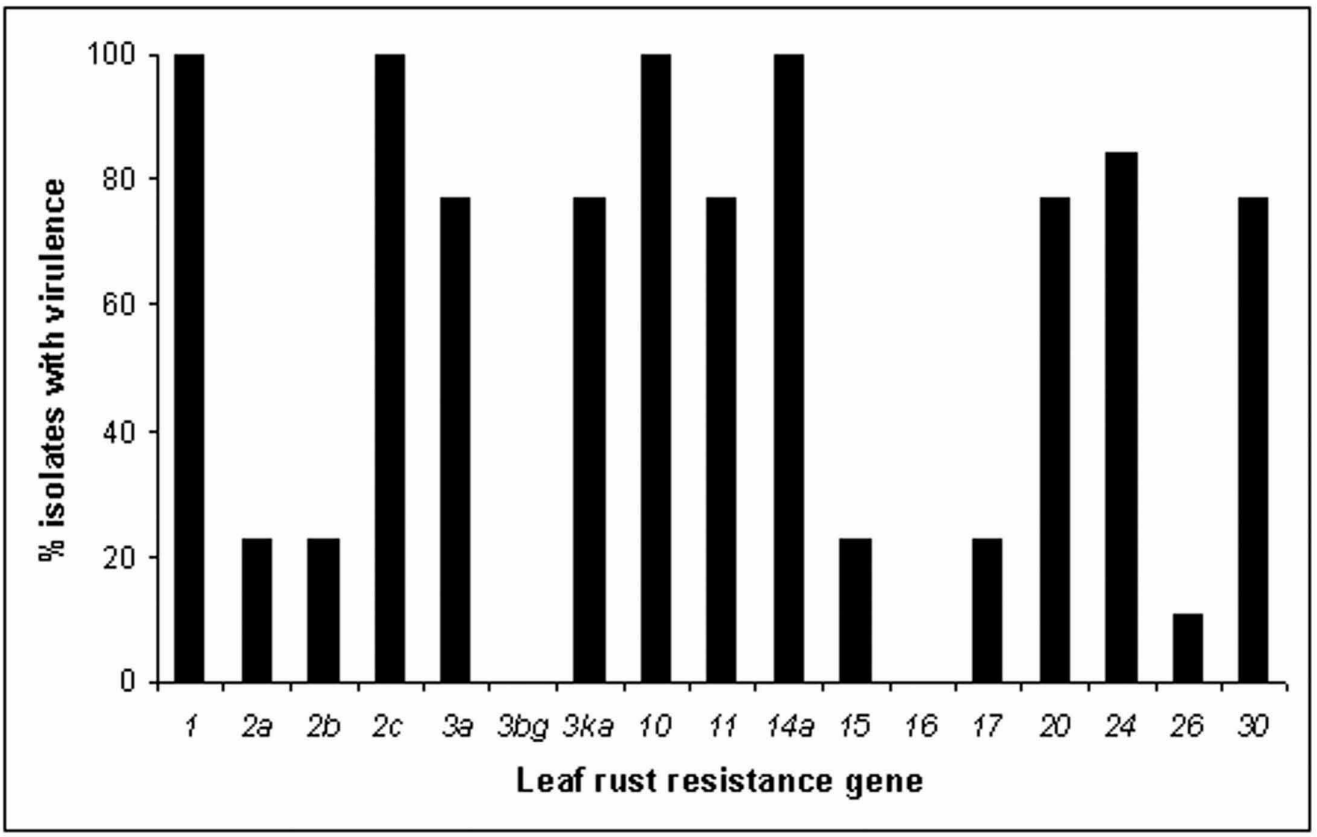

Figure 2 Percentages of *Puccinia trticina* 2007 isolates that were virulent on different leaf rust resistance genes

Acknowledgements

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