Stem rust resistance in South African wheat cultivars

Pretorius ZA[1], Jin Y[2], Prins R[1,3], Bender CM[1] and Herselman L[1]

Department of Plant Sciences, University of the Free State, Bloemfontein 9300, South Africa; [2]U.S. Department of Agriculture-Agricultural Research Service, Cereal Disease Laboratory, University of Minnesota, St. Paul, MN, USA; [3]CenGen (Pty) Ltd, 78 Fairbairn St., Worcester 6850, South Africa.

ABSTRACT

The appearance and anticipated spread of race TTKS (syn. Ug99) of *Puccinia graminis* f. sp. *tritici* have renewed interest in breeding for durable resistance to stem rust of wheat. In an attempt to determine the current status of stem rust resistance in South African (SA) bread wheat, 67 cultivars and lines were tested with US and East African races of *P. graminis* f. sp. *tritici*. Entries were also screened with DNA markers associated with *Sr24* (*Sr24#50*) and *Sr31* (*iag95*). *Sr2* DNA marker (*stm559n*) data were compared with seedling chlorosis scores to validate the use of this marker in SA genotypes. Most cultivars interacted differentially with the races tested. DNA marker analysis confirmed the presence of *Sr31* in seven and *Sr24* in 12 entries. *Stm559n* for *Sr2* reliably amplified the correct allele in most local and control lines. However, in several instances the *Sr2*-associated allele was amplified in presumably non-*Sr2* carrying cultivars. This study emphasized that diversification of resistance sources is needed as few SA wheat entries appear to have a broad-based resistance to stem rust.

INTRODUCTION

Stem rust, caused by *Puccinia graminis* f. sp. *tritici*, has been an important disease of bread wheat in South Africa (SA) for many years (Pretorius et al., 2007). Over the past three decades regional epidemics have occurred as a result of breakdown of genes such as *Sr9e* and *Sr24* in wheat and *Sr27* and *SrSatu* in triticale. At present stem rust occurs mostly on spring wheat and triticale grown in the winter rainfall areas of the Western Cape. Despite its regular occurrence, information on the genetic base of stem rust resistance in leading SA wheat cultivars and breeding lines is limited. The objective of this study was to determine the status of stem rust resistance in advanced germplasm. In view of recent pathogenic adaptation for virulence in East Africa (Jin et al., 2008), emphasis was placed on the occurrence of *Sr24* and *Sr31* in SA wheats.

MATERIALS AND METHODS

A collection of 54 wheat cultivars and 13 breeding lines was tested for seedling resistance to stem rust races BCCB, MCCF, QFCS, QTHJ, RCRS, RKQQ, TPMK, TTTT, TTKSK and TTKST at the USDA Cereal Disease Laboratory in St Paul, USA. Infection types (ITs) were scored according to a 0 to 4 scale (Stakman et al., 1962) 14 days after inoculation. ITs of 2 and lower were considered indicative of resistance and 3 to 4 as a susceptible host response. The collection was also screened at the University of the Free State, SA for the expression of seedling chlorosis, a phenotype reported to be linked to *Sr2* (Brown, 1997). Plants were inoculated with stem rust isolate UVPgt55 12 days after sowing and, following a dew period, kept at 25 to 28°C in a greenhouse. Seedling chlorosis was rated 16 days after inoculation. Suneca (*Sr2*) and Morocco (susceptible) were included as controls. Entries were tested for the *Sr2* marker *stm559n,* which replaced *stm559tgag* (Hayden et al., 2004; M.J. Hayden, University of Adelaide, personal communication), as well as the *Sr31* marker *iag95* (Mago et al., 2002; 2005) and the *Sr24* marker *Sr24#50* (Mago et al., 2005).

RESULTS AND DISCUSSION

Fifty three entries were susceptible to at least one of the 10 stem rust races tested, implying non-durable, hypersensitive resistance in the majority of cultivars. Vulnerability to the African races in particular was emphasized by 42 entries being susceptible to either one of races TTKSK and TTKST. The cultivars Duzi, Caledon, Elands, Pan 3404, Pan 3492, Pan 3364, SST047, SST57, SST94, SST347, SST399 and Steenbras, and experimental lines Mon Exp 2 and Mon Exp 3, were resistant to all races.

Typical seedling chlorosis was observed on the *Sr2* control Suneca. However, the relationship between seedling chlorosis and the *stm559n* marker was not conclusive. Either seedling chlorosis was not equally expressed in the different wheats or the marker detected a similar allele in non-*Sr2* genotypes. Nonetheless, several genotypes apparently lacking *Sr2* were identified for marker-assisted introgression of this gene. Further work is required to confidently detect *Sr2* through marker and seedling assays. In addition, these tests have to be confirmed by stem rust response and pseudo-black chaff expression in the field. Marker analysis confirmed *Sr24* in 12 entries. This frequency is lower than expected as 20 entries were postulated to contain the gene based on the IT range (1 to 2) normally associated with *Sr24*. Although *Sr31* is not commonly used in South African wheat breeding, seven entries contained the *iag95* marker. All entries carrying this marker had low ITs typical of the *Sr31* phenotype to the US races. Except for line Mon Exp 3 (IT 2-), all *Sr31* wheats were fully susceptible as seedlings to TTKSK and TTKST.

Sixteen entries, five of which were resistant to all races, were postulated to carry the *SrTmp* gene. Despite being non-durable elsewhere, this gene is still effective in SA. Caution should thus be exercised in cultivars classified as resistant under SA conditions as some of them may rely on single gene resistance. Genetic studies, incorporating both seedling and adult-plant resistance, need to be conducted on resistant cultivars. Breeders could then discern between complex and monogenic resistance and use sources with the best potential of durability in their programs. It is widely accepted that resistance based on hypersensitive seedling resistance is not durable. If effective seedling genes are used, they have to be protected in backgrounds displaying adequate adult plant resistance.

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