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EVALUATION OF TIMOPHEEVI WHEATS FOR RESISTANCE TO RUSTS AND POWDERY MILDEW

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ABSTRACT

Twenty four accessions of timopheevi wheats were screened for adult plant resistance to stem rust, leaf rust, stripe rust and seedling resistance to powdery mildew at Wellington, a hot spot for rusts and other foliar diseases of wheat. The majority of *Triticum timopheevi* accessions exhibited high mature plant resistance to stem, leaf and stripe rusts and seedling resistance to powdery mildew. The only strain of *T. militinae*, a mutant of *T. timopheevi*, was found totally free from infection of all the three rusts and powdery mildew. However, the strains of *T. araraticum* showed high susceptibility to all three rusts but showed low infection to powdery mildew. *T. timopheevi*-derived genes Sr36, Sr37 were found effective against stem rust and Pm6 against powdery mildew.

Key words: *Triticum timopheevi, T. militina, T. araraticum*, rust resistance, powdery mildew, specific genes.

Wild emmer and timopheevi group of wheats have enormous genetic diversity with regard to many characteristics. Amongst them, *Triticum timopheevi* holds great potential for disease resistance, particularly rusts. Ever since Pridham [1] developed the common wheat variety Timvera deriving its resistance from *T. timopheevi*, there have been successful transfers of *timopheevi*-derived resistance to common wheat by different workers, the best known specific gene being Sr36 (Sr Tt1) for stem rust. The present study has assessed the disease resistance potential available in timopheevi group of wheats.

MATERIALS AND METHODS

Fifteen accessions of *Triticum timopheevi* Zhuk. obtained from Japan (1), Israel (2), U.S.A. (2), U.K. (1), USSR (5), IARI, New Delhi (4); 1 accession of *T. militinae* from USSR and 8 accessions of *T. araraticum* Jakubz. from Israel (3), U.S.A. (2), Japan (1), U.K. (1) and IARI, New Delhi (1) were critically evaluated for 14 seasons under high incidence of natural infection of stem, leaf and strips rusts at Wellington, a hot spot for rusts and other foliar diseases of wheat. The adult plant reactions to rusts were recorded by combining severity (percentage of infection) and response (type of infection). Accessions were also screened against powdery mildew in seedling stage. The seedling inoculations were made in the greenhouse [2], and the seedlings were scored for resistance to powdery mildew on 0–4 scale as per Powers [3].

RESULTS AND DISCUSSION

An examination of Table 1 reveals that the majority of accessions of *T. timopheevi* exhibit high resistance to stem rust (*Puccinia graminis* f. sp. *tritici* Eriks. & Henn.) leaf rust (*P. recondita* R. ex Desm.), stripe rust (*P. striiformis* West), and powdery mildew (*Erysiphe graminis tritici* em. Marchal). The only strain of *T. militinae* evaluated was found resistant to all three rusts and powdery mildew. However, the strains of *T. araraticum* having the same genomic constitution (AAGG) as *T. timopheevi* showed high susceptibility to all three rusts but low infection of powdery mildew.

Table 1. Adult plant reactions (range) of timopheevi wheats to stem rust, leaf rust, stripe rust and seedling reactions to powdery mildew

Accession number	Species	Reaction to			
		stem rust	leaf rust	stripe rust	powdery mildew
SWAN 281	*Triticum timopheevi*	F	F	F	0
SWAN 282	*T. timopheevi* TIM 01	F-10S	F	F	0
SWAN 283	*T. timopheevi* var. *typica*	F-10S	F	F	0
SWAN 284	*T. timopheevi*	F	F	F	0
SWAN 285	*T. timopheevi* G 921	F	F	F	0
SWAN 286	*T. timopheevi*	F	F	F	0
SWAN 287	*T. timopheevi*	F-5S	F	F	0
SWAN 288	*T. timopheevi*	F	F	F	0
SWAN 289	*T. timopheevi*	F	F	F	0
SWAN 290	*T. timopheevi* V 359	5S-40S	F	F	0
SWAN 291	*T. timopheevi* V 361	F	F	F	0
SWAN 292	*T. timopheevi*	F-5S	F	F	0
SWAN 293	*T. timopheevi*	F	F	F	0
SWAN 453	*T. timopheevi* K 28541	F	F	F	0
SWAN 454	*T. timopheevi*	F	F	F	0
SWAN 499	*T. militinae*	F	F	F	0
SWAN 295	*T. araraticum*	40S-70S	50S-70S	F	0
SWAN 296	*T. araraticum* G 1767	50S-80S	70S-90S	F	0
SWAN 297	*T. araraticum* G 2382	50S-80S	40S-70S	F-30S	0
SWAN 298	*T. araraticum* G 2541	60S-70S	50S-70S	F-40S	0
SWAN 299	*T. araraticum* VIR 31628	60S-80S	30MS-50MS	F-10S	1
SWAN 300	*T. araraticum* WL	50S-80S	40MS-60MS	F-20S	1
SWAN 301	*T. araraticum* TA 02	60S-70S	60S-70S	F-30S	0
SWAN 303	*T. araraticum*	60S-80S	50S-70S	F-5S	2

SWAN—Species Wellington Accession Number.

Migusova and Smel'kova [4] evaluated wheats with G genome and found *T. militinae*, a pubescent mutant of *T. timopheevi*, to be least susceptible to stem rust. Assessment of *T. timopheevi* accessions to diversify the sources of resistance to a number of wheat pathogens, particularly for rust, has been carried out by several workers. McIntosh and Gyarfas [5] evaluated 19 accessions of *T. timopheevi* and found that 15 accessions carried the stem rust resistance gene Sr Tt1 (Sr36). They also reported that accessions of *T. araraticum* had no common major resistance gene with *T. timopheevi*. Studies on 15 accessions of *T. timopheevi* indicate that many lines manifest moderate to high seedling resistance to 14 cultures of Indian stem rust races [6]; and most lines exhibit resistance to the most prevalent race 21.

Pridham [1], Shands [7] and Allard [8] were successful in transferring stem rust and leaf rust resistance from *T. timopheevi* to cytologically stable common wheats. Bartos and Sebesta [9] also successfully exploited *T. timopheevi*-derived resistance to stem rust and leaf rust in two Czechoslovakian wheat varieties, Uhretice 22/IV and 22/IV. Allard and Shands [10] developed two red hard spring wheats, CI 12632 and CI 12633, having the stem rust resistance derived from *T. timopheevi.* In addition to stem rust resistance, these selections also carry high degree of resistance to powdery mildew. These lines carry gene Sr36[5]. The present authors evaluated CI 12632 and CI 12633 for over 14 seasons and found them showing consistently low reactions to stem rust at adult plant stage as well as seedling resistance to the powdery mildew race(s) occurring in the Nilgiris. Since these lines frequently exhibited mesothetic reactions of moderate intensity to leaf rust, it may be presumed that the *T. timopheevi*-derived factor(s) is/are effective at least to some cultures of *Puccinia recondita* prevailing in the Nilgiris.

The stem rust races/biotypes 11, 14, 15, 15C, 17, 21, 21A-1, 24, 34, 34A, 40, 40A, 42, 42A, 42B, 72, 117, 117A, 117A-1, 122, 184, 194, 222, and 295 have been reported from the Nilgiris (S.D. Singh, personal communication). Sawhney and Goel [6] reported gene Sr36 to be effective against 12 cultures, viz., 14, 34, 40A, 42, 42B, 117, 117A, 122, 184, 194, 222 and 295, of Indian stem rust races/biotypes at seedling stage. A high resistance to stem rust at adult plant stage is also evident in the Australian cultivars, such as Timgalen, Mendos, Mengavi, Timson and Timvera, all carrying gene Sr36 (Table 2). These varieties have also shown moderately high resistance to powdery mildew, indicating the association of Pm6 gene with Sr Tt1 (Sr36). The resistance gene Pm6 (Mlf) has also been reported to be closely associated with Sr36 earlier [11, 12].

Table 2. Reactions of wheat strains carrying specific genes from *T. timopheevi* to rusts and powdery mildew

Wheat strain	Specific gene (s) present	Reaction to			
		stem rust	leaf rust	stripe rust	powdery mildew
CI 12632	Sr36, Pm2*, Pm6	TR–TS	50X–70X	30S–40S	1
CI 12633	Sr36, Pm2*, Pm6	F–TS	50X–70X	30S–40S	1
Mengavi	Sr36	TMR–TS	50S–80S	30S–40S	3
Timgalen	Sr36, Sr5*, Sr6*, Sr8*	F–20MR	40S–70S	50S–70S	3
Timvera	Sr36, Lr18	TR–TS	20MS–50S+	30S–40S	—
Line W	Sr37	TR–TS	20X–50S	20S–80S	—
HW 657	—	TS–5S	20S–60S	20S–80S	3
HW 888	—	TS–10S	10S–40S	TS–20S	3

* These genes have not been derived from *T. timopheevi.*
+ Intensity of leaf rust is higher at maturity.

The gene Sr 36 exhibited effective durable resistance to stem rust races in Australia, as is evident from the variety Timgalen released in 1967, which, however, became susceptible to a new virulence in 1984 (McIntosh, personal communication). Varieties

HW 657 and HW 888 involving Timgalen as one of the parents, are resistant to stem rust at most locations in the country. Thus, this gene is still very effective in India. Another *T. timopheevi*-derived gene, Sr Tt2 (Sr37) [5], was also found effective against the stem rust races occurring in the Nilgiris.

We have tested 17 diverse strains of *T. dicoccoides* for disease resistance and found them more similar to *T. araraticum* with respect to susceptibility to stem rust, leaf rust, stripe rust and powdery mildew. *T. araraticum* is a Transcaucasian wild winter wheat, first described under the name of *T. dicoccoides* ssp. *armeniacum* by Jakubziner [13]. Morphologically, *T. araraticum* closely resembles *T. dicoccoides*. However, genetically, *T. araraticum* is more akin to *T. timopheevi*. Gerlach et al. [14] showed, on the basis of satellite DNA analysis, that a chromosome similar to 4A was present in *T. timopheevi* but not in *T. araraticum*. Although *T. araraticum* and *T. timopheevi* possess similar genome (AAGG) and have closer genomic affinity [15], they exhibit a significant difference in their reactions to various rust and powdery mildew infections. It is interesting to note that the accessions of *T. timopheevi* are resistant to the stem rust, leaf rust, stripe rust and powdery mildew pathogens occurring in the Nilgiris, while the strains of *T. araraticum* show relatively high susceptibility to the same pathogens. This may be either due to frequent gene exchange between *T. araraticum* and other tetraploid and hexaploid wheats or spontaneous mutation, or a combination of both. Wagenaar [16] postulated that *T. timopheevi*, the only true spring type in this group, evolved through a series of chromosomal rearrangements from *T. araraticum* var. *nachitachevanicum*. *T. timopheevi* may have been picked up by the local farmers in Georgia/Armenia, being suitable for cultivation, and they might have improved its resistance by selection.

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