Triticeae Genebank Collection as a Source of Resistance to Fungal Diseases

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Abstract: The wild *Triticeae* collection in Prague was initiated in 1985 with the acquisition of *Aegilops* collection from IPK Gatersleben. The collection has been extended to other *Triticeae* species, samples being acquired through staff collecting and exchanges. At present the collection includes 1508 accessions belonging to 23 genera and 133 species. The largest subcollections are *Aegilops, Triticum, Elymus, Leymus,* and *Hordeum*. Most of the accessions are documented with *Herbarium exsiccatae* from the wild localities or from cultivation. The whole collection is documented in the information system EVIGEZ. Characterization and evaluation data are available for most of the accessions. The accessions have been tested for resistance to leaf diseases. The testing was performed on adult plants in an infection field or on seedlings in the greenhouse. Inoculation was with mixture of most virulent races or by individual races of *Puccinia graminis, P. recondita, P. striiformis* and *Blumeria graminis*. The evaluation shows a large diversity in plant responses. In some cases the response was uniform for population, accession or a species but, in most cases, the response varied considerably within accessions. Nevertheless, it is possible to identify some accessions of each species with combined resistance that is promising for breeding.

Keywords: *Triticeae*; genetic resources; evaluation; rust; powdery mildew

The Department of Genetic Resources was an important part of Research Institute of Crop Production from the very beginning for the maintenance of cultivated cereals. Primitive cultivated and some wild wheat species were introduced from VIR Leningrad in 1970s. The first non-*Triticum* wild species, a part of a large *Aegilops* collection was brought to RICP from IPK Gatersleben by Jan Valkoun for evaluation in the beginning of eighties. They were accepted by the Departmental Gene Bank in 1985. The wild Triticeae collection in Prague has continued to develop since that time (Holubec *et al*. 1992). The collection was soon extended to other *Triticeae* species, samples being acquired through exchange and collection. A simultaneous development of the documentation system (Rogalewicz *et al*. 1986) made necessary further characterization and evaluation of the accessions. The *Triticeae* accessions have been evaluated for various characters among which disease resistance have a priority. Presence of resistance genes in cultivars is the most effective way to prevent diseases and to avoid the associated yield and grain quality losses (Stepien *et al*. 2002). In spite of the fact that alien genes conferring resistances to various pathogens have been widely used in breeding (Friebe *et al*. 1996), there is still a high demand for quality genetic resources.

MATERIAL AND METHODS

The *Triticeae* collection at present includes 1508 accessions plus about 150 samples in the working collection (Table 1). The largest part is represented by genera *Aegilops, Triticum, Hordeum* and *Elymus*. The monotypic genera *Hordelymus, Pascopyrum* and *Heteranthelium* are poorly represented by accessions. Similarly, *Elymus* is represented by the highest number of species but most species are represented by only one or two accessions.

Table 1. The *Triticeae* collection of Gene Bank Prague-Ruzyně, numbers of accessions evaluated on rust and powdery mildew resistance

Genus	No. acces. in collect.	No. spp. in collection	No. of tested accessions
Subtribus *Agropyrinae* Nevski			
Agropyron J.Gaertn.	48	5	21
Subtribus *Hordeinae* Dumort.			
Crithopsis Jaub. et Spach	7	1	5
Elymus L.	89	40	56
Elytrigia Desv.	14	5	8
Heteranthelium Hochst.	5	1	4
Hordelymus (Jessen) Harz	2	1	1
Hordeum L.	96	17	30
Leymus Hochst.	45	15	28
Lophopyrum A. Löve	8	3	4
Pascopyrum A. Löve	2	1	2
Psathyrostachys Nevski	23	2	10
Pseudoroegneria (Nevski) A. Löve	10	4	8
Taeniatherum Nevski	20	2	15
Thinopyrum A. Löve	12	2	5
Total subtribus	333	94	143
Subtribus *Triticinae* Trin.			
Aegilops L.	915	21	784
Triticum L.	150	5	120
Secale L.	22	3	10
Dasypyrum (Coss.et Dur.) T. Duran	25	1	20
Eremopyrum (Ledeb.) Jaub. et Spach	15	4	8
Total subtribus	1127	34	942
Total *Triticeae*	1508	133	1106

On the contrary, some species are represented by many accessions. For example, there are 182 accession of *Aegilops tauschii*. Its high representation reflects the fact that it is a desirable species for breeding because it is a direct ancestor to wheat, being the source of the D- genome. In addition representatives of several less know genera, such as *Henrardia* from the fourth subtribe *Henrardiinae* of the *Triticeae* and *Parapholis*, and *Hainardia* from the closely related tribe *Hainardieae* are included in the collection and evaluation, but their cultivation has been only partly successful.

The accessions in the *Triticeae* collection come from various donors. Most of the *Aegilops* accessions were originally received from IPK Gatersleben, and a considerable number of the perennial species came from the U.S.D.A.'s Forage and Range Research Laboratory. The other part, mainly of newer materials, comes from collecting expeditions.

The evaluation of the *Triticeae* collection was done as the accessions were received and multiplied. The characterizing of the collection follows the minimum standards for gene bank collections including basic morphological and phenological traits and diseases.

The accessions were subsequently tested for resistance to leaf diseases. The testing was done on adult plants in an infection field and/or on seedlings in the greenhouse for 2–4 years. The plants were inoculated with a mixture of the most virulent races or by single races of stem rust (*Puccinia graminis* f. sp. *tritici* Erikss. et Henn), leaf rust (*P. recondita* Rob. ex Desn.), stripe rust (*P. striiformis* Westend), and powdery mildew (*Blumeria graminis* (DC.) Speer f. sp. *tritici* (em. Marchal). In addition, *Epichloë typhina* (Pers. Fr.) Tul. was observed in perennial species trials. In addition, some samples were tested for resistance to single races. The evaluation

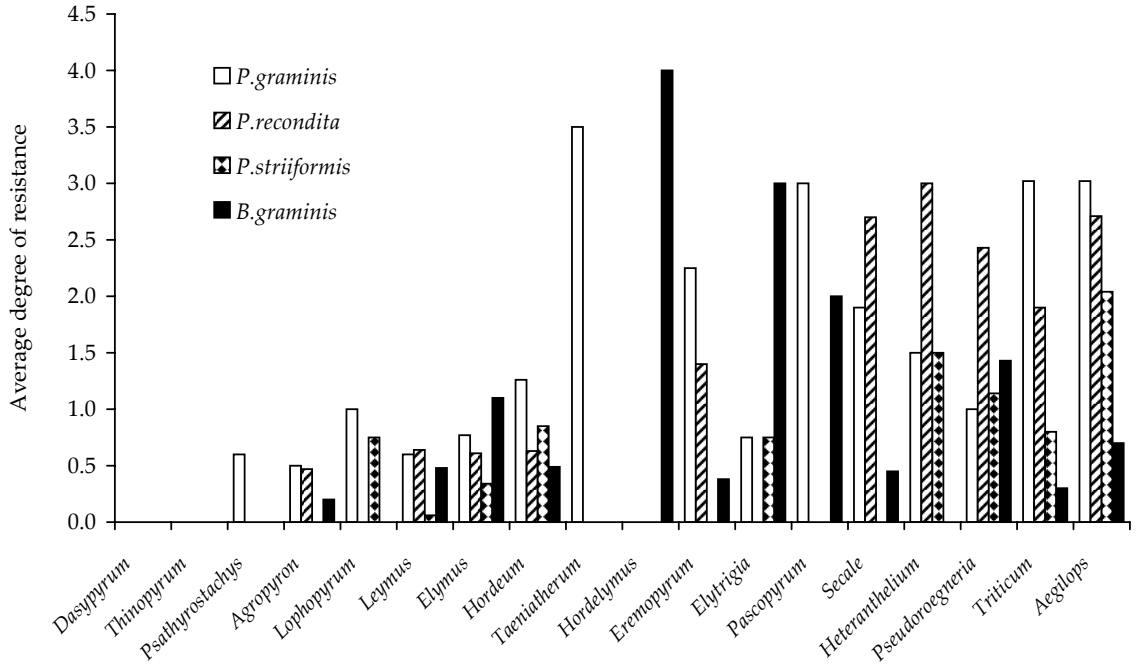

Figure 1. Average *Triticeae* genera resistance to leaf, brown and stripe rusts and powdery mildew

scale was 0–4 (0–1 resistant, 2 partially resistant, 3 partially susceptible, 4 susceptible) used in RICP (Bartoš *et al*. 2002).

RESULTS AND DISCUSSION

Results from repeated disease evaluation were summarized over nearly 20 years. A total of 1106 accessions (73% of the collection) have been evaluated, *Aegilops* and *Triticum* species had a higher priority and were repeatedly evaluated for at least 3 years.

Figure 1 shows the cumulative average degree of evaluation for each genus. Stem rust infestation was highly prevalent in most of genera, while yellow rust was highly developed mainly for *Heteranthelium, Pseudoroegneria* and *Hordeum*. Brown rust was generally highly developed in *Aegilops, Triticum, Secale, Pseudoroegneria* and *Heteranthelium. Hordelymus europaeus* was susceptible only to powdery mildew, but this result is based on the single accession in the collection. *Elytrigia, Pascopyrum* and *Pseudoroegneria* were generally highly susceptible to powdery mildew. In the cumulative view for all four diseases, the mostly highly susceptible genera were *Aegilops, Triticum, Pseudoroegneria* and *Heteranthelium*. The genera *Psathyrostachys* and *Taeniatherum* were only infected by stem rust.

On the specific level the results were variable for polygenomic genera like *Aegilops, Triticum* and *Hordeum*, but also for *Elymus* and *Leymus*. On the other hand not much variation was found in *Heteranthelium, Dasypyrum, Taeniatherum* and *Eremopyrum*. Within *Triticum*, the highest degree of resistance to leaf diseases was found in *T. araraticum*. The only cultivated species in the collection, *T. monococcum*, showed a high level of resistance to all three pathogens. *Triticum urartu* was highly susceptible, but the results of the past 5 years were influenced by the fact that it was raised in the presence of BYDV. Within *Aegilops*, the most resistant species over years appeared to be *Ae. speltoides* and *Ae. comosa*. A relatively higher degree of resistance to leaf rust was present in *Ae. crassa, Ae. entricosa,* and *Ae. biuncialis.* There was a higher resistance level to stripe rust in *Ae. juvenalis, Ae. kotschyi, Ae. columnaris, Ae. biuncialis, Ae. triuncialis, Ae. neglecta,* and *Ae. ventricosa.*

Secale montanum, S. anatolicum, Eremopyrum distans and *E. orientale* were highly susceptible to stem and brown rusts. *Leymus akmolinensis, L. angustus*, and *L. karelinii* were highly susceptible to brown rust.

The results of *Triticeae* collection evaluation are summarized also according to percentage of resistant, moderately resistant, moderately susceptible, and susceptible accessions. The percentage of resistant accessions is shown in the Figure 2. The closest relatives of the cereals, *Aegilops, Triticum, Secale* and *Hordeum* appear in the worst end of the

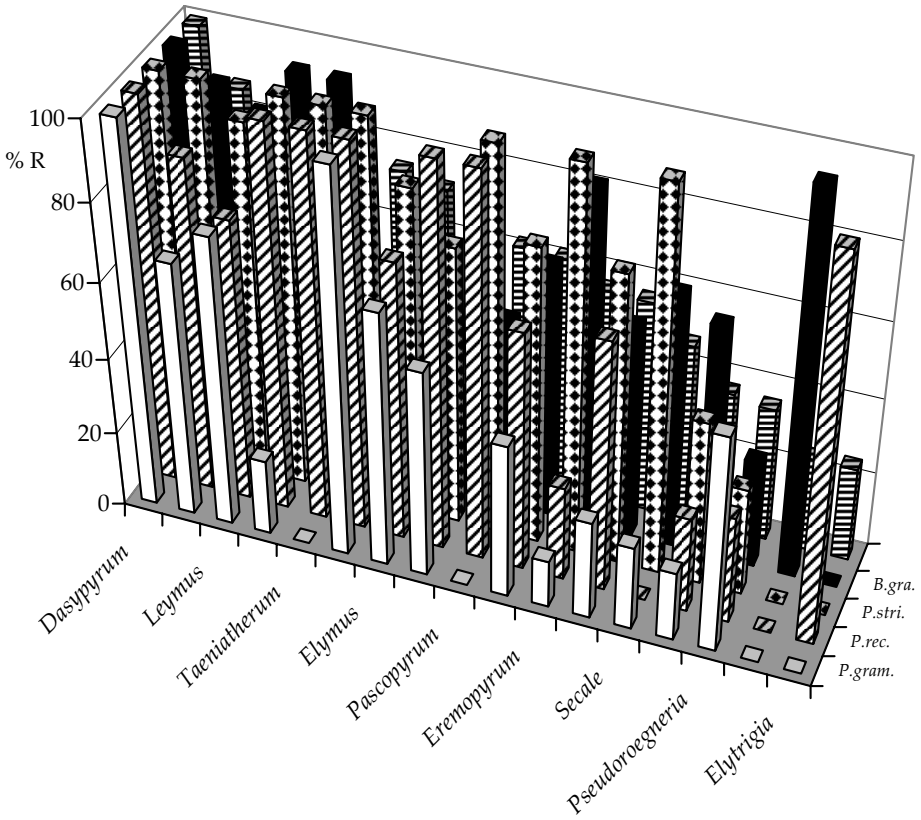

Figure 2. Percentage of resistant *Triticeae* accessions to leaf, brown and stripe rusts and powdery mildew

graph, indicating that few of the accessions in the collection of these genera have high resistance to the diseases tested. *Dasypyrum* and *Agropyron* showed the highest percentage of resistant accessions. The genera *Hordelymus*, *Psathyrostachys* and *Taeniatherum* showed 10% of resistance to three diseases.

While in some genera the summarized evaluation is valid for lower levels, specific and accession, in other genera the variation at the accession level makes it impossible to make a single summary statement. Breeders must evaluate not only accessions but single plants to get useful and applicable results.

Summarizing and analyzing of gene bank evaluation data reveals a tremendous breeding potential of *Triticeae* that has been only minimally exploited up to now. It can give breeders a primary orientation in searching among not or rarely used germplasm of secondary and tertiary gene pool.

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