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Role of related species in genetic improvement of cultivated wheats

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Renewed interest was given recently to related species of cultivated wheats as a source for important agronomic characters.

On the other hand continued selection for high yielding varieties has considerably reduced the genetic variability. New varieties have largely replaced the old traditional ones. Thus the gene pool of cultivated wheats has become greatly limited. Since most new varieties have similar genetic material, their uniformity reduces the possibility of further improvement and also determines in wheat high vulnerability to diseases and climatic hazards (Feldman, 1977).

Consequently, as far as diseases are concerned it is the uniformity of cultivated varieties themselves that favours the appearance and rapid spreading of new virulence factors in the pathogen population. Therefore the tremendous evolution of virulence genes observed in some parasites with respect to resistance factors introduced in cultivated varieties in the Mediterranean Basin, as well as striking epidemics of new diseases oblige plant breeders to look for different resistance sources particularly in wild species (Zitelli et al., 1977). At present the studies on related species continue to be the most important tool available for increasing genetic variability. However, a successful utilization of related species germplasm depends on the better information now available on biology, cytogenetics and evolutionary relationship between wild and cultivated forms of *Triticum*. This allows the reproductive barriers to be more easily overcome than in former years.

At present, the disease resistance and other useful characters can be easily transferable (Gerechter - Amital et al., 1971) using relatively simple and direct procedures such as introgression (Vardi and Zohary, 1967).

Adoption of this procedure makes it possible to transfer genetic material from wild diploid progenitors to tetraploid cultivated wheats by backcrossing via a triploid bridge.

In recent years, to pick up as many different resistant genes as possible, a systematic and careful screening for resistance sources to various diseases (rusts, powdery mildew, septoriosis, etc.) was carried out on cultivated and wild forms of *Triticum* species (*T. monococcum*, *T. turgidum* and

Aegilops) as well as on other genera like: Secale, Agropyrum and Haynaldia.

Results obtained, by testing large collections of T. dicoccum, T. monococcum and Aegilops (diploid and polyploid) in the field and in the greenhouse with respect to stem and leaf rust and powdery mildew, will be discussed.

These species were chosen for their ready crossability with T. durum. In fact, T. dicoccum (AABB) and T. monococcum (AA), having the same genome or one genome in common with "durum" wheat (AABB), offer the advantage of giving fertile or partially fertile hybrids.

Also different Aegilops species were chosen, some of them being ancient progenitors of present tetraploid and hexaploid cultivated wheats. Aegilops, because of the big structural differences (genomic and morphologic) occurred in the evolution of wheat, has no immediate possibility of utilization even though there are some valid results to record (Sears, 1956; Kerber and Dyck, 1969).

Materials and methods

Since the scope of these investigations was to widen the resistance "spectrum" of new Italian "durum" wheats, the biotypes used for screening were chosen for their virulence on some resistant "durum" varieties belonging to "Val" group (Table 1). Some of these biotypes namely N16, N21 of Puccinia graminis tritici, B9 and B22 of Puccinia recondita tritici and V4 of Erysiphe graminis tritici, which were identified only sporadically in the Italian pathogen populations, at the moment do not represent an immediate danger but they could spread rapidly in the near future. Particularly N21 of stem rust and V4 of powdery mildew show their extreme virulence with respect to known resistance genes (Table 1).

The 309 strains of T. dicoccum (Gras, 1980) were tested at the seedling stage with biotypes N16, N15, N21 of stem rust, B22 of leaf rust and V4 of powdery mildew.

In previous work Vallega (1977 and 1978) examined more than a hundred forms of T. monococcum utilizing for leaf rust and mildew different biotypes and for stem rust only N16 and N15. Now the infections have been repeated on 122 strains using N16, N15 and N21, B22 and V4 biotypes.

The 296 accessions of Aegilops (diploid and polyploid) (Pasquini, 1980) were tested with N21 of stem rust, B22, B21, B9 of leaf rust and V4 of mildew. This is because more resistance genes are expected for leaf rust than stem rust.

Results

The data obtained analyzing these species demonstrate that they represent a vast reservoir of resistance genes to three diseases considered together or separately. T. dicoccum and T. monococcum were shown to be useful sources of resistant genes offering currently effective resistance to all three diseases in, respectively, 11% and 14% of strains. A significantly lower percentage was shown by Aegilops diploid and polyploid species.

Concerning reactions of T. dicoccum, T. monococcum and Aegilops (diploid and polyploid) species to single biotypes, the following considerations can be made. For what concerns stem rust, T. monococcum and to a lesser extent T. dicoccum seem to be the most useful sources of resistance genes also to the extremely virulent N21 biotype. Several resistant strains are present in different Aegilops species (Ae. speltoides, Ae. uniaristata, Ae. caudata, Ae. ovata, Ae. triaristata, Ae. triuncialis, etc.), but many of these, resistant in the greenhouse, showed susceptibility in the field when exposed to the heterogeneous pathogen population.

T. dicoccum offers lower resistance to leaf rust than other wheat species.

None of T. monococcum strains was susceptible to different leaf rust biotypes, confirming studies carried on by The (1975, 1976, Vallega (1977, 1978). However we do not know for sure if this kind of leaf rust resistance can be easily transferred, because hybridization between T. monococcum and "durum" varieties had the main objective to widen resistance spectrum of durum "Val" group, until now immune to leaf rust.

Only this year one biotype, variant of 211 race, has been isolated from one single sample collected in Sicily able to attack Valgerardo. Therefore a leaf rust test with this variant F_1 backcross and F_2, F_3 progenies will enable us to make preliminary considerations on this interesting problem.

Aegilops species represent an important resistance source to leaf rust. Especially Ae. speltoides, very closely related to wheat, shows a wide resistance "spectrum", while the reactions of Ae. squarrosa (Pasquini, 1980), the diploid donor of D genome, appear variable.

All species examined showed various sources of resistance genes to mildew different from Pm4. This is because V4, virulent on Pm4 but sporadically present in Italy (Ceoloni and Vallega, 1978), was used for screening (Table 1). The gene Pm4 is considered until now the only effective gene in Italy incorporated in rather widely cultivated "durum" varieties.

In conclusion, as T. dicoccum, T. monococcum and Aegilops species were found to include a wide array of resistance to stem rust, leaf rust and mildew, these species could be considered as a potential source for resistance to diseases in wheat.

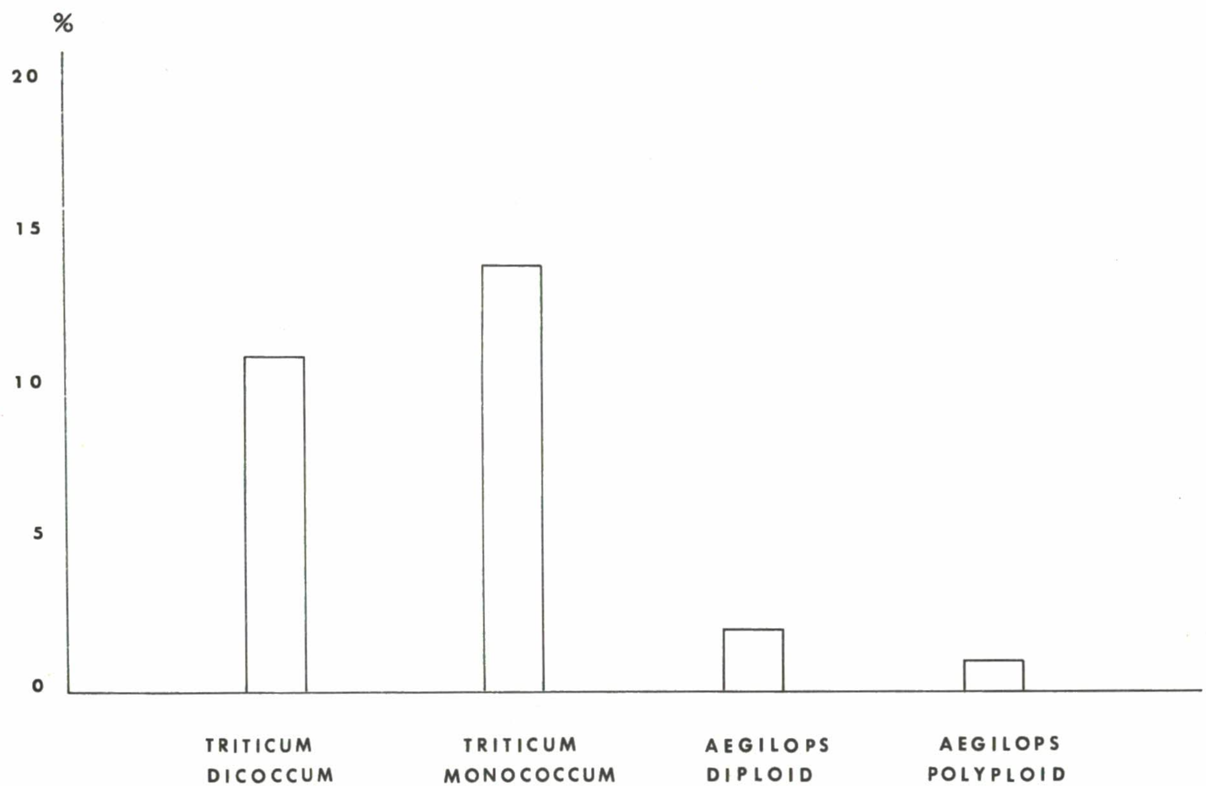
However it is T. monococcum among the species examined which offers higher and practical facility of utilization because of its easy and ready crossability with cultivated wheats (tetraploid and hexaploid) as well as for its wide range of resistance factors to various diseases.

Table 1. - Seedling reaction of differential set and of some commercial varieties to biotypes of *Puccinia graminis*, *P. recondita* and *Erysiphe graminis* used for the screening.

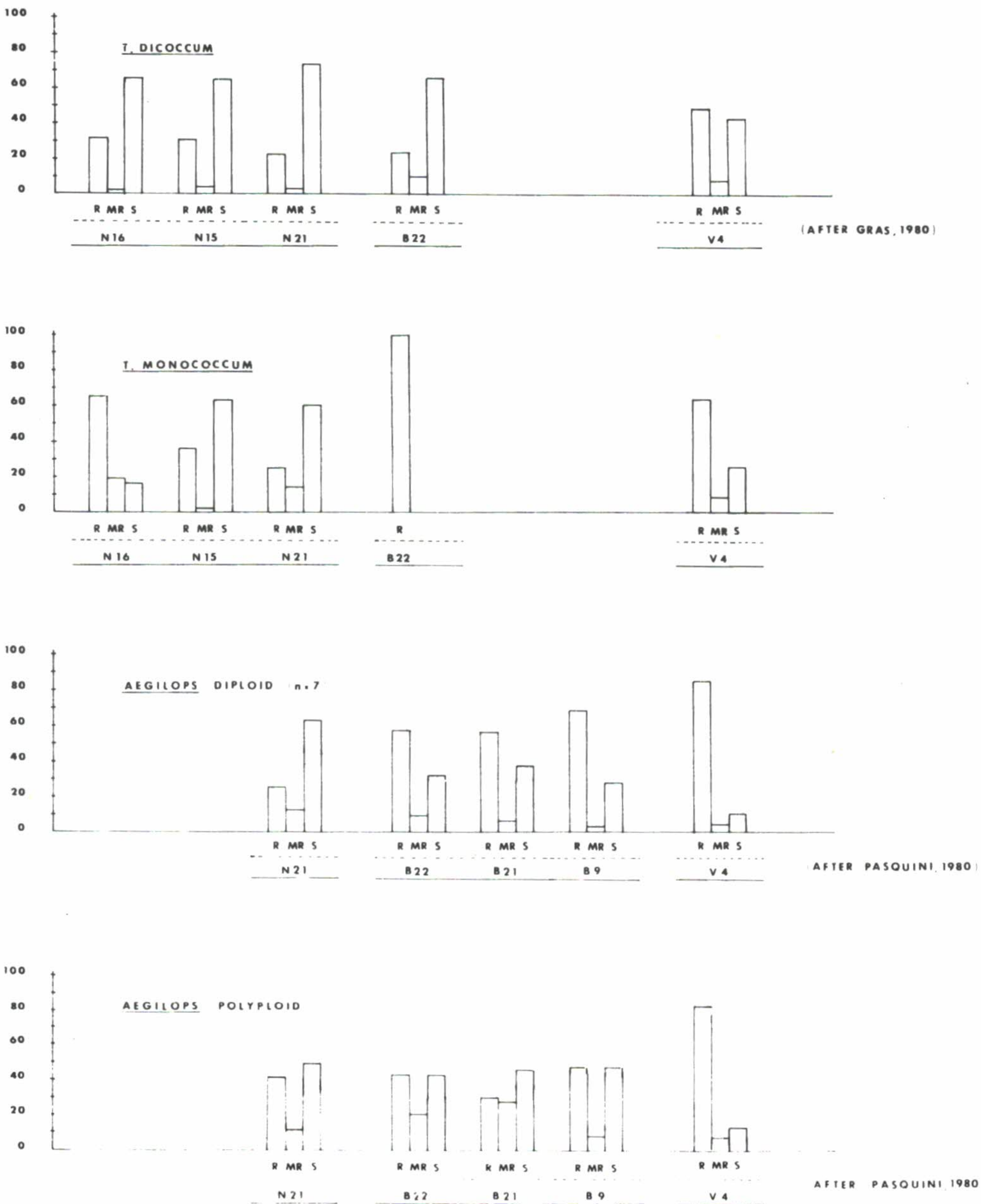
Differential set	Physiologic races 11	14	116	12	77	211	V4
	Biotypes N.21	N.15	N.16	B.21	B.9	B.22	B.II
Puccinia graminis							
I Sr5 - Ra (CI. 14159)	S◀	R	R				
I Sr6 - Ra (CI. 14163)	S◀	S◀	MS◀				
I Sr8 - Ra (CI. 14167)	MR	R	S◀				
I Sr11- Ra (CI. 14171)	S◀	R	R				
Sr 13 W 2691 (CI. 17387)	MS◀	MR	R				
Sr 14 Kapt. M^{10} la 1.2	S◀	R	R				
Sr Tt. 1 W 2691 (CI. 17385)	S◀	S◀	R				
Mentana	MR	R	S◀				
Hope	S◀	R	MR				
Agrus	R	R	R				
Agatha (Sr 25)	R	R	R				
L e e (Sr 11 +)	MS◀	R	R				
Erysiphe graminis							
Khapli C.I. 4013							S◀
Khapli x Cc^8							S◀
Yuma C.I. 13245							S◀
Yuma x Cc^8							S◀
Vernal C.I. 3686							R
Einkorn C.I. 2433							S◀
Chul x Cc^8							R
Normandie C.I. 12747							S◀

Puccinia recondita							
Lr 1 "Centenario"				R	S ◀	R	
Lr 2a "Webster"				R	MS ◀	R	
Lr3 "Democrat"				S ◀	S ◀	MR	
Lr3 Ka. "Aniversario"				MR	MR	MS ◀	
Lr9 "Aegilops umbellulata"				R	R	R	
Lr17 "Klein Lucero"				MS ◀	MS ◀	R	
Lr19 "Agatha"				R	R	R	
Lr24 "Agent W 3564"				R	R	R	
Ardito sel. Klein				R	R	R	
Klein Aniversario				R	R	R	
Klein Lucero (Lr17 +)				R	R	R	
Elia				R	R	R	
Commercial and resistant varieties							
Valgerardo	S ◀	S ◀	R	R	R	R	S ◀
Valnova	S ◀	S ◀	R	R	R	MR	S ◀
Valsacco	R	R	S ◀	R	R	MR	S ◀
Valfiora	R	R	S ◀	MR	MR	MS ◀	S ◀
Valgiorgio	R	R	S ◀	S ◀	MS ◀	S ◀	S ◀
Valitalico	R	R	S ◀	R	R	MR	S ◀
Cappelli	MS ◀	S ◀	MS ◀	S ◀	S ◀	MR	S ◀
Trinakria	MS ◀	MS ◀	MS ◀	MS ◀	MS ◀	MR	S ◀
Gaza	MR	R	R	R	R	R	S ◀

PERCENTAGE OF *T. DICOCCUM*, *T. MONOCOCCUM*, *AEGILOPS* DIPLOID AND POLYPLOID SPECIES RESISTANT TO THREE PARASITE.



STRAINS PERCENTAGE IN T.DICOCCUM, T. MONOCOCCUM AND AEGILOPS SPECIES (DIPLOID AND POLYPLOID), RESISTANT (R), MODERATELY RESISTANT (MR) AND SUSCEPTIBLE (S) TO BIOTYPES: N16, N15 AND N21 OF P.GRAMINIS; TO BIOTYPES B22, B21 AND B9 OF P. RECONDITA AND TO POPULATION V4 OF E.GRAMINIS.



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