Rep. Plant Germ-plasm Inst. Kyoto Univ. No. 4: 18–22 (1979)

Speciation of wild tetraploid wheats concerning susceptibility to leaf rust

Hatsuo SAITO and Norio ISHIDA

Chugoku National Agricultural Experiment Station, Fukuyama, Hiroshima and Faculty of Agriculture, Kyoto University

The phylogenetic relationships between the Emmer group and Timopheevi group of wild tetraploid wheats have been studied by many workers from various viewpoints.

The authors newly attempted to analyze their phylogenetical relationship by applying the relation between higher plants and its parasites: Host-Parasite interaction. Namely, we attempted to contemplate the phylogenetical relationship of wild tetraploid wheats concerning the intraspecific variation of susceptibility and its geographical distribution by investigating the susceptibility of them to leaf rust.

Materials and Methods

Leaf rust used in this experiment was an isolate of *Puccinia recondita* Roberge et Desm. f. sp. *tritici* which was native on wheat leaves (*Triticum durum* Desf.) cultivated at Agricultural Station, Sulaymanyah, IRAQ in 1970. This race has been consecutively incubated on *T. aestivum* L. cultivar Norin 16 at the Laboratory of Plant Pathology, Faculty of Agriculture, Kyoto University. This race was identified as that belonging to Race group I by the method proposed by Chester (1946). This race is designated as "Mesopotamia race" because of the collection locality.

The wheat materials used in present study are listed in Table 1. These strains are two species of wild tetraploid wheats belonging to Emmer and Timopheevi groups. These strains, 108–1, 109–1 and 110, were *T. dicoccoides* native to Palestine, and two strains, 196–1 and 196–2, were *T. araraticum* native to Transcaucasus. The rest 30 strains native to Mesopotamia (from 8491 to 8948) including both species were collected by the Botanical Expedition of Kyoto University to the Northern Highland of Mesopotamia in 1970 (BEM, 1970). These strains have been maintained at the Plant Germ-plasm Institute, Kyoto University.

The susceptibility of wheat materials was analyzed by observation and judgement of their infection types to leaf rust fungus (*Puccinia recondita* Roberge et Desm. f. sp. *tritici*, a Mesopotamia race). At the 1 to 3 leaf stage the seedlings were inoculated by the brushing technique with a urediospore suspension on the first leaf for seedling reaction. Inoculated plants were held in a humidity chamber at 20±2 C for 20–22 hr. Plants were then placed in the greenhouse at 20–25 C for 14 days under natural condition. The rust reaction of each plant was scored after complete maturation of urediosorus, approximately 2 weeks after inoculations.

This experiment was carried out in a greenhouse at the Laboratory of Plant Pathology, Faculty of Agriculture, Kyoto University.

Ta

Region-Spe		
Palestine:		
T. dicoccoides Körn.		
Transcaucasus:		
T. araraticum Jakubz.		
Mesopotamia:		
T. dicoccoides Körn.	Su	
	Row	
	Amad	
	Sinjar,	
	Silvan, Tu	
	Ergani, //	
	Ravansir, Ira	
T. araraticum Jakubz.	Sulaymaniya, I	B, 8552, 8567, 8593, 8610
	Koi-Senjaq, //	
	Rowanduz, //	8714A, 8733, 8741, 8784
	Amadiya, //	8870
	Silvan, Turkey	8924
	Hozat, //	8938
	Karand, Iran	8948

1) Stock No. is based on the No. of Plant Germ-Plasm Institute, Faculty of Agriculture, Kyoto University (KU).

Results

The results of inoculation experiments are summarized in Table 2. As shown in Table 2, *T. dicoccoides* collected in Palestine region and *T. araraticum* collected in Transcaucasus region were completely susceptible and highly resistant, respectively. Also, both species in those regions showed extremely stable responses and difference among strains was never observed.

On the contrary, the susceptibility of both species collected in Mesopotamia had a wealth of various forms. Namely, out of 15 *dicoccoides* strains, 13 strains were highly susceptible, but two strains (8935 and 8937B) were highly resistant. These resistant strains were collected in the suburbs of Ergani in Turkey, where will be the northern limit of the distribution of this species (Fig. 1). Also, the responses of *T. araraticum* were not uniform, namely, out of 15 strains, 8 strains were resistant (8610, 8700, 8714A, 8741, 8784, 8870, 8938 and 8948), three were resistant to moderately resistant (8491, 8567 and 8593), one was moderately resistant (8924), one was moderately resistant to susceptible (8733), and two were susceptible (8528B and 8552). The localities of respective rust-infection type in wild tetraploid wheats are showed in Fig. 1.

From the above results, it can be surveyed that both species in Mesopotamia region showed from resistant to susceptible reactions, meaning the divergency of susceptibility, especially *T. araraticum* showed its extremely various reactions.

Table 2. Susceptibility of various strains of wild tetraploid wheats to leaf rust (*Puccinia recondita* f. sp. *tritici*)

Region-species	Stock No.	Infection type[1)]	No. of strains
Plaestine-*dicoccoides*	108-1, 109, 110	S(4)	3
Transcaucasus-*araraticum*	196-1, 196-2	R(0–1)	2
Mesopotamia-*dicoccoides*	8536, 8541, 8736A, 8736B, 8737, 8804, 8817, 8821A, 8821C, 8915A, 8915B, 8941, 8942	S(4)	13
	8937B	R-MR(1–2)	1
	8935	R(0)	1
Mesopotamia-*araraticum*	8610, 8700, 8714A, 8741, 8784, 8870, 8938, 8948	R(0–1)	8
	8491, 8567, 8593	R-MR(0–2)	3
	8924	MR(2)	1
	8733	MR-S(2–3)	1
	8528B, 8552	S(3)	2

1) S=Susceptible (3 or 4), MR=Moderately resistant (2), R=Resistant (0 or 1)

Discussion and Conclusion

In this paper, wild tetraploid wheats native to Palestine, Transcaucasus and Mesopotamia are called Palestine type, Armenia type and Mesopotamia type, respectively.

The cytological studies revealed that Palestine and Armenia type belonged to *T. dicoccoides* and *T. araraticum*, respectively, and that there was a reproductive isolation based on different genome constitutions and some remarkable morphological differences between them (Lilienfeld and Kihara 1934, Svetozarova 1939, Wagenaar 1961, Tanaka and Ichikawa 1972).

In this experiment, these two types showed completely different reactions to Mesopotamia race of leaf rust, i.e., Palestine type was susceptible but Armenian type was resistant without exception. And both types showed completely stable reactions in all cases (Table 2). On the contrary, Mesopotamia type is composed of two species, i.e., both *T. dicoccoides* and *T. araraticum*. As shown in Table 2, it becomes evident that resistant strains of *T. dicoccoides* and various strains from susceptible to resistant of *T. araraticum* exist in addition to those showing completely stable reactions like Palestine and Armenian type, as mentioned above.

The fact that *T. dicoccoides* and *T. araraticum* in Mesopotamia consist of resistant and susceptible strains suggests the existence of variability concerning the genes which control susceptibility to leaf rust. Especially, *T. araraticum* showed typical continuous variation of wide reaction spectrum ranging from resistant to susceptible (Table 2). In Mesopotamia, the wild tetraploid wheats are distributed concentrically in the Zagros Mountains (Tanaka and Ishii 1973). Strains used in this experiment were adequately extracted from its all regions and the relation between its geogrephical distribution and susceptibility to leaf rust did not clearly show a localization except *T. dicoccoides* strains, as shown in Fig. 1.

The above mentioned results seem to support the assumption that Mesopotamia, especially the Zagros Mountains, is the centre of genes controlling susceptibility to leaf rust and the differ-

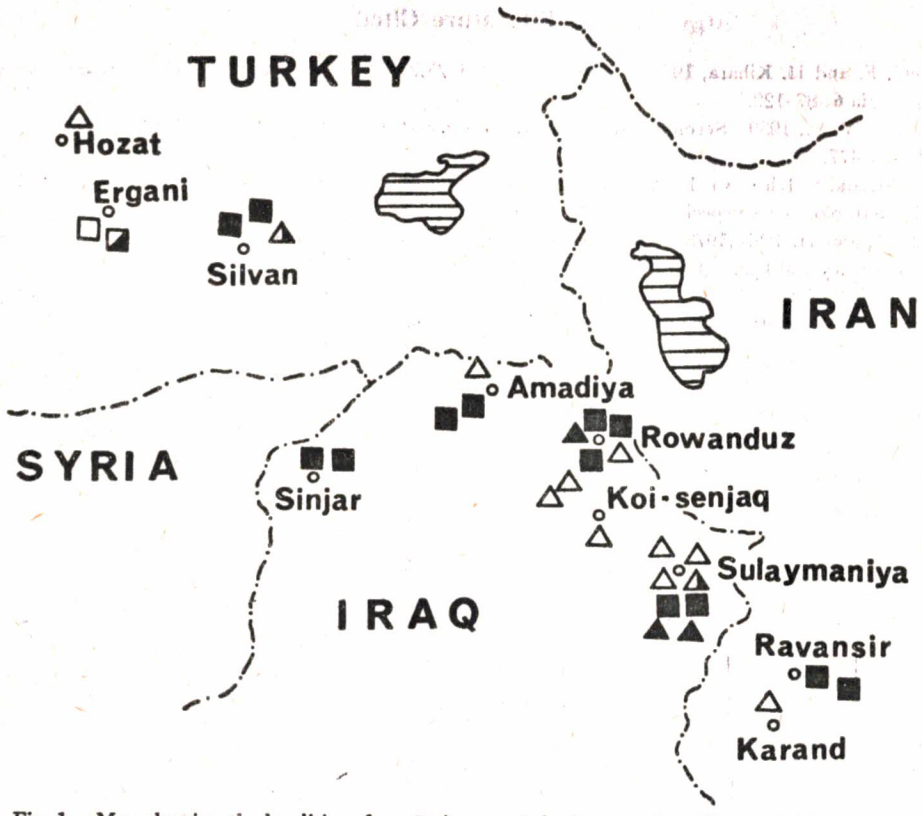

Fig. 1. Map showing the localities of respective rust-infection type in wild tetraploid wheats.
T. araraticum: △=R, ◭=MR, ▲=S.
T. dicoccoides: □=R, ◪=MR, ■=S.

entiation concerning susceptibility have proceeded in Transcaucasus and in Palestine far from the centre under certain ecological condition. It can be interpreted as follows: 1) Mesopotamia region is a dry climate. The selection of disease tolerance to parasite did not probably occur in this region. 2) Palestinian *dicoccoides* is distributed in drier environments than in Mesopotamia and the requirement of disease resistance was not primarily important to grow under ecological conditions. 3) On the contrary, existence of resistant strains in Armenian *araraticum* indicates a positive adaptation to rather moist steppe conditions of Transcaucasus.

From the cytogenetical bases, Tanaka and Ishii (1973) assumed that *T. dicoccoides* and *T. araraticum* originated from a single ancestor through the structural differentiation of chromosomes in Mesopotamia. It is unquestionable that the results of the inoculation experiments will provide an evidence supporting the above assumption. It also suggests that the analysis of susceptibility to rust is a method of a useful approaches to clarify the origin and evolution of the wild tetraploid wheats.

Literature Cited

Lilienfeld, F. and H. Kihara, 1934 Genomanalyse bei *Triticum* und *Aegilops*. V. *Triticum timopheevi* Zhuk. Cytologia **6**: 87–122.

Svetozarova, V. V., 1939 Second genome of *Triticum timopheevi* Zhuk. Comp. Rend. Acad. Sci., U.S.S.R. **23**: 473–477.

Tanaka, M. and S. Ichikawa, 1972 Cytogenetical relationships of two types of *Triticum araraticum* Jakubz. to other tetraploid wheat species. Japan. J. Genet. **47**: 103–114.

Tanaka, M. and H. Ishii ,1973 Cytogenetical evidence on the speciation of wild tetraploid wheats collected in Iraq, Turkey and Iran. Proc. 4th Int. Wheat Genet. Symp. 115–121.

Wagenaar, E. B., 1961 Studies on the genome constitution of *Triticum timopheevi* Zhuk. I. Evidence for genetic control of meiotic irregularities in tetraploid hybrids. Can. J. Genet. Cytol. **3**: 47–60.