Physiologic Specialization of Loose Smut of Wheat in the Punjab State of India

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ABSTRACT

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Three races (T1, T10, and T11) of *Ustilago tritici* were identified from the Punjab State of India. The incidence of T1, T10, and T11 was 8.8, 30.0, and 61.3%, respectively. Composition of the loose smut population was not affected by climatic conditions but by the predominant wheat cultivars in a region. Partial infection of wheat heads was found to be due to environmental factors rather than to any specific race.

Physiological variability in *Ustilago tritici* (Pers.) Rostr. was first investigated by Tiemann (15). Since then, many workers have worked on this aspect of *U. tritici* in various parts of the world. Two types of differential sets have been employed in these investigations. Radulescu (14), Bever (3), and Batts (1) used cultivars of winter wheat as differentials, whereas Oort (12), Cherewick (4), and Medeiros and Nielsen (10) used spring wheats as differentials.

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Gothwal and Pathak (6) identified eight races in India on the basis of the reaction of the Canadian set of differentials. Only three races identified by these workers appeared to have an equivalent among the 36 races so far identified in the world on the basis of this differential set (J. Nielsen, *personal communication*). Unfortunately, teliospores or seeds infected with these eight races were not available for comparison.

Our study deals with physiological variability in *U. tritici* in the Punjab by using the 18 Canadian differentials.

MATERIALS AND METHODS

Eighty samples of *U. tritici* were collected from five districts of the Punjab in paper bags, dried, and stored in a refrigerator. Each sample consisted of one smutted head and originated from submountainous (districts of Hoshiarpur, Gurdaspur, and Ropar), humid (districts of Ludhiana and Sangrur), and arid (Sangrur II) zones and from the commonly grown wheat cultivars recommended by the Punjab Agricultural University (PAU), Ludhiana, viz. WL 711, KSML 3, WL 1562, Kalyansona, HD 2009, C 306, Sonalika, PV 18, WL 410, and WG 357. The samples had either completely or partially infected florets.

Teliospores of each sample were multiplied and maintained on a highly susceptible cultivar, WL 711, grown in an isolated block. Inoculations were done at midanthesis by the modified technique of Poehlman (13). Twenty to 30 heads were inoculated with a syringe with a water suspension of teliospores of each isolate. At maturity, the inoculated heads were harvested, thrashed, and the infested seeds stored in paper bags. The teliospores produced on plants from such inoculated seed were used to inoculate the differential set.

Eighteen differential wheat cultivars of Canadian genotype (10) were used to identify the variability in *U. tritici*. Cultivars were sown at staggered dates in 5-m rows with a row-to-row distance of 60 cm under medium-fertility conditions in the PAU Research Farm. Inoculations were done with dry teliospores. The heads were prepared for inoculation by removing the upper and lower spikelets and cutting the upper one-third part of the glumes without causing any injury to the anthers or stigma. The heads so prepared were covered with butter paper bags (22.5 × 10 cm). The bag was cut from the top, and the teliospores from an infected head were gently dusted on the enclosed ear. Five to 10 heads for each differential cultivar were inoculated. The heads were kept covered with the butter paper bags until harvest. The infested heads were harvested separately and the seeds stored in paper bags.

Seeds of the inoculated differentials were sown in the field in 5-m rows with a plant-to-plant distance of 15 cm and a row-to-row distance of 30 cm. The data recorded were based on the percentage of plants infected, and only the differentials that gave an infection higher than 10% were considered susceptible (2,8).

Samples that gave similar reaction were grouped as one entity of the pathogen, and an infected head representing the sample was selected. Teliospores from such samples were used for further pathogenicity tests on these differentials to confirm the results.

RESULTS

Three groups, each with a distinct virulence pattern of *U. tritici*, were identified (Table 1). Collections of group 1 infected only Kota, Little Club, Reward, and PI 298554. Virulence of this group of collections was identical to Canadian race T1. Race T1 was present in three of the five districts of the Punjab; it was not detected in Hoshiarpur and Ludhiana districts (Table 2). Its incidence ranged from 9.5 to 25%. Race T1 was not detected in the arid zone and had an incidence of only 9.8% in the submountainous zone and 10.7% in the humid zone.

Collections of group 2 infected eight differentials, i.e., Kota, Little Club, Reward, Carma, Kearney, Thatcher × Regent, PI 298554, and C.T. 439. Virulence of this group of collections was identical to that of Canadian race T10 (Table 1). Of five districts sampled in this study, race T10 was detected in all except Hoshiarpur. The incidence ranged from 23.8 to 45.5% and was higher than that of T1 at all locations. Race T10 had a maximum incidence of 45.5% in an arid zone and a minimum of 24.4% in a submountainous zone.

Collections of group 3 infected only two differentials, i.e., Reward and PI 298554. This group resembled in its virulence pattern Canadian race T11 and was probably identical with the previously determined (6) Indian race LSR_7 (Table 1). Race T11 was detected in all five districts of the Punjab investigated in this study. The lowest incidence of 41.6% was found in Sangrur District, whereas the maximum incidence of 100% was found in the Hoshiarpur District (Table 2). Race T11 was found in all bioclimatic regions of the Punjab. It had a maximum incidence of 65.9% in the submountainous zone and a minimum of 54.5% incidence in the arid zone.

Race T11 was found on all 10 wheat cultivars sampled. Race T10 was collected on the wheat cultivars Kalyansona, C 306, Sonalika, and PV 18, whereas race T1 was found only on C 306.

All three races (T1, T10, and T11) were detected from partially infected heads. Wheat cultivar WL 711 and susceptible differentials, when inoculated with teliospores from partially infected ears, produced completely infected heads in the next crop.

DISCUSSION

From 80 collections of *U. tritici* on wheat from the Punjab, the three races T1, T10, and T11 were identified. Race T1 was reported earlier from the Punjab (11). Races T10 and T11 may be similar to Indian races LSR_3 and LSR_7 (6). However, the latter two were determined on the basis of a differential set that had only nine of the present 18 differentials in common. Moreover, the unavailability of spores of LSR_3 and LSR_7 prevented confirmation of this similarity.

Bioclimatic conditions seem to have little effect on the distribution of races of *U. tritici*. It is evident that T11 is the most prevalent race in Punjab as a whole as well as in all its three bioclimatic regions. The next most prevalent race is T10. The absence of race T1 from the arid zone may be due to the smaller number of samples tested from that region.

Table 1. Reactions of differential cultivars to the isolates of *Ustilago tritici* from the Punjab and to already described races in Canada and India

	Races of loose smut of wheat[a]							
	Present study			Canada			India	
Differential	Group 1	Group 2	Group 3	T1	T10	T11	LSR_7	LSR_3
Mindum	R	R	R	R	R	R	R	R
Renfrew	R	R	R	R	R	R	R	R
Florence × Aurore	R	R	R	R	R	R	R	R
Kota	S	S	R	S	S	R	R	S
Little Club	S	S	R	S	S	R	R	S
Reward	S	S	S	S	S	S	S	S
Carma	R	S	R	R	S	R	R	R
Kearney	R	S	R	R	S	R	R	S
Red Bobs	R	R	R	R	R	R	R	R
Pentad	R	R	R	R	R	R	R	R
Thatcher × Regent	R	S	R	R	S	R	NT	NT
PI 298554	S	S	S	S	S	S	NT	NT
Sonop	R	R	R	R	R	R	NT	NT
H_{44} × Marquis	R	R	R	R	R	R	NT	NT
Marroqui 588	R	R	R	R	R	R	NT	NT
Rio Negro × Bage	R	R	R	R	R	R	NT	NT
C.T. 439	R	S	R	R	S	R	NT	NT
Wakooma	R	R	R	R	R	R	NT	NT

[a] Only susceptible reaction (S), over 10% smut infection, has been given. S = susceptible, R = resistant and NT = not tested.

Table 2. Incidence of races of loose smut of wheat in the Punjab

	Incidence of races (%) by zones and districts								
	Submountainous				Humid			Arid	
Race	Gurdaspur	Hoshiarpur	Ropar	Disease incidence	Ludhiana	Sangrur I[a]	Disease incidence	Sangrur II[b]	Punjab
T1	9.5 (2)[c]	0.0 (0)	14.3 (2)	9.8 (4)	0.0 (0)	25.0 (3)	10.7 (3)	0.0 (0)	8.8 (7)
T10	23.8 (5)	0.0 (0)	35.7 (5)	24.4 (10)	31.3 (5)	33.3 (4)	32.1 (9)	45.5 (5)	30.0 (24)
T11	66.6 (14)	100.0 (6)	50.0 (7)	65.9 (27)	68.8 (11)	41.6 (5)	57.1 (16)	54.5 (6)	61.3 (49)

[a] Sangrur I = Ahmedgarh.
[b] Sangrur II = Barnala.
[c] Numbers of samples tested given in parentheses.

Similarly Grevel (7) from Germany also reported that the distribution of races of loose smut was not correlated with geographical area.

In these investigations, race T11 was isolated from all cultivars from which samples were collected, but race T10 was collected on only four wheat cultivars, i.e., Kalyansona, C 306, Sonalika, and PV 18, whereas race T1 was found on only cultivar C 306. This indicated the selectivity of a race for a particular genotype. Introduction of new cultivars of wheat is known to change the prevalence of different races of *U. tritici* (3).

Because all three races were originally collected in the form of both partially or completely infected heads and teliospores from partially infected heads, when inoculated on different wheat cultivars produced completely infected heads in the next crop, it is inferred that partial infection was not due to a difference in race.

Dean (5) reported 23 C to be the ideal temperature for smut development, whereas higher (5) or lower (9) temperatures are known to cause partial infection. It is therefore suggested that partial infection in our investigation was also due to environmental factors rather than to any specific race.

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