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WHEAT (*Triticum* L.) CULTIVARS FROM GRIN COLLECTION (USA) SELECTED FOR DURABLE RESISTANCE TO *Septoria tritici* AND *Stagonospora nodorum* BLOTCH

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Abstract

Septoria tritici blotch (STB) or *Stagonospora nodorum* blotch (SNB) are among the most harmful and economically significant diseases of wheat in the grain growing regions of the world, especially in the countries with a temperate climate. In epiphytotic years the losses from the disease can reach 30-40 %. In Russia the diseases holds a dominant position in a pathogenic complex of fungus diseases of grain crops. In this paper we first determined the parameters of partial resistance in the cultivars of wheat (genus *Triticum*) from the collection of the Germplasm Resources Information Network (GRIN, USA) using the stable strains of *Septoria tritici* and *Stagonospora nodorum* pathogens. The aim of our study was to select wheat varieties with long-term resistance to blotch based on field and laboratory tests. A long-term study (2009-2015) of the disease development on the wheat cultivars from GRIN Collection were conducted at artificial infection in infection nursery (Central region of Russia, Moscow Province). The samples studied belonged to various genetic groups. A total of 20 samples were diploids ($2n = 14$), 409 samples were tetraploids ($2n = 28$), 1688 samples were hexaploids ($2n = 42$), and also 397 lines derived from crossing of *Triticum aestivum* with *Aegilotriticum* were tested. The area under disease progress curve was determined, and the index of resistance (IR) was calculated. The cultivars, that characterized by slow development of the disease in the field, i.e. with high-and middle IR, were selected for laboratory studies. The plants were grown in artificial climate chambers till the 3rd leaf fully unfolded. Pieces of leaves were inoculated by a drop of spore suspension of *S. tritici* (4 isolates) or *St. nodorum* (4 isolates), 10 replications per each variety-to-pathotype combination. The samples were grouped according to the latent period length and size of infectious spots. As a result, 191 samples of *T. aestivum* subsp. *aestivum* and a sample of *T. aestivum* subsp. *spelta* with a high index of resistance to the disease were selected among hexaploid wheat; 16 samples were found in tetraploid wheat, including 8 samples of *T. turgidum* subsp. *durum*, 2 samples of *T. turgidum* subsp. *turgidum*, 3 samples of *T. turgidum* subsp. *dicoccon*, 3 samples of *T. timopheevii* subsp. *timopheevii*; and 4 samples were selected from diploid wheat *T. monococcum* subsp. *aegilopoides*. Eleven lines derived from crossing of *T. aestivum* and *Aegilotriticum* sp. showed the slowed-down in the disease development. The selected hexaploid wheat cultivars were mostly from North American ecology-geographical group of *T. aestivum* subsp. *aestivum*, including 77 cultivars from the USA and 18 — from Canada (34.5 % in total). Selected tetraploid wheat samples of *T. turgidum* subsp. *durum* were from North and Central America, and those of *T. turgidum* subsp. *turgidum*, *T. timopheevii* subsp. *timopheevii* and *T. turgidum* subsp. *dicoccon* from Europe and Asia. The samples from Iraq and Hungary with a high index of blotch resistance were found among diploid wheat *T. monococcum* subsp. *aegilopoides.* The synthetic lines of wheat from the USA and Mexico were also characterized by a slowed-down development of the disease. Thus the wheat cultivars with partial resistance have been revealed, including 10 cultivars with partial resistance to *Septoria tritici* blotch and 40 cultivars — to *Stagonospora nodorum* blotch. The accessions PI 494096 Tadinia, Cltr 17904 Owens, Cltr 15645 II-62-4 (USA), VIR 63915 Flame (England), Cltr 14492 Azteca, PI 520555 Alondora 'S' (Mexico), PI 404115 Timson (Australia), Cltr 11765 Chinese 166 (Germany), PI 422413 CNT 1 (Brazil), PI 168724 Benvenuto, Cltr 15378 Piamontes, PI 344468 Piamontes Inta (Argentina), PI 306551 2944 (Romania), PI 355706 69Z5.715 (Azerbaijan), PI 355560 SK 1B (Switzerland), PI 94743 290 (Russia) are of special interest for breeding as a source of long term resistance.

Keywords: *Septoria tritici* blotch, STB, *Stagonospora nodorum* blotch, SNB, partial re-

sistance, long-term resistance, *Triticum* L., diploid, tetraploid and hexaploid wheat, synthetic lines, the Germplasm Resources Information Network (GRIN) Collection

Septoria blotch is one of the most dangerous and economically significant diseases of grain crops in the majority of regions with a temperate climate [1, 2]. The greatest harmfulness of the disease was noted in France, Great Britain, Germany, Poland, Belgium, Czech Republic, the Netherlands, in Scandinavian countries (Norway, Sweden, and Finland), Lithuania, and Latvia [3-7). Cases of Septoria blotch were recorded in North Africa (Tunisia, Algeria, Morocco, Ethiopia) and Australia, Northern Caucasia (Georgia), North America (the USA, Canada) and South America (Mexico, Argentina) [8-15]. In Russia, Septoria blotch holds a dominant position in a pathogenic complex of fungus diseases of wheat plantings. The disease poses the highest priority danger in Central, Southern, North Caucasian, North-Western, Privolzhsky, and Siberian Federal regions [16-18]. In epiphytotic years, the crop losses from the disease can reach 20-40 % [19-23]. Septoria blotch reduces the photosynthetic activity of plants and causes the ear malformation. The assimilation surface of leaves decreases, the stems are die-back and folded (as a result of severe node damages), early ripening and shortfall of grains are observed. In case of severe damage of crops, Septoria blotch may cause seedlessness and death of individual plants. If the disease appears later the grain yield diminishing does not generally exceed 5-7 % [24-26]. The Septoria blotch pathogens can affect all the aboveground organs of plants. There are about 16 names of these fungi in the literature, but their taxonomy generates a lot of differences. The best known species now are *Septoria tritici* Rob. Et Desm.; *Stagonospora nodorum* (Berk.) E. Castellani and E.G. Germano and *Stagonospora avenae* Bissett f. sp. *triticea* T. Johnson [25].

There is almost no wheat breeding for resistance to Septoria blotch in our country, although the disease has been starting to spread throughout Russia since early 1970s, and currently it is present in nearly every region where spring and winter wheat is cultivated. The development of resistant cultivars requires donors, the sources of resistance genes, which can be searched for only among varieties of world collections. The most long-lasting protection against Septoria blotch is provided by partially resistant varieties which are characterized by slower development of the disease in field, can reduce the probability of epiphytotics and extend the duration of resistance retention in a cultivar [25, 27].

In this paper, we have determined for the first time the parameters of partial resistance in the cultivars of wheat from the collection of the Germplasm Resources Information Network (GRIN, USA) using the stable strains of *Septoria tritici* and *Stagonospora nodorum* pathogens.

The aim of our study was to select wheat cultivars with the durable resistance to Septoria blotch based on field and laboratory tests.

Technique. Dynamics of Septoria blotch development in wheat samples (genus *Triticum*) from the GRIN collection (Germplasm Resources Information Network, USA) was studied in 2009-2015 in an infection nursery located at the Central Region of Russia (Moscow Province, Odintsovo Region, trial fields of All-Russian Research Institute of Phytopathology, ARRIP). The study was conducted in 2117 wheat samples from various genetic groups, including 20 diploids ($2n = 14$), 409 tetraploids ($2n = 28$), 1688 hexaploids ($2n = 42$), and also 397 selection samples derived from crossing of *Triticum aestivum* with *Aegilotriticum* sp.

Area under disease progress curve (ADPC) was determined by the method of D.A. Johnson et al. [28] based on results of 5 and more measurements of Septoria blotch affection intensity for plants during the growing season:

$$S = {}^1/_2\ (x_1 + x_2)(t_2 - t_1) + ... + (x_{n-1} + x_n)(t_n - t_{n-1}),$$

where S is the area under disease progress curve; n is the number of measurements; x_1, x_2, x_n are a degree of the disease development at the time of the 1st, 2nd and last measurements, respectively, %; $(t_2 - t_1)$ is the time interval between the 2nd and the 1st measurements, days; $(t_n - t_{n-1})$ is the time interval between the last and second to last measurements, days.

Index of resistance (IR) was calculated by the formula proposed by A.A. Makarov et al. [29] as a ratio of the ADPC for the cultivar tested to that for the susceptible control: $IR = ADPC_{cultivar}/ADPC_{control}$. Based on the IR value, the cultivars were conditionally divided into 4 groups: cultivars having high (0.10-0.35), medium (0.36-0.65), and low (0.66-0.80) IR, and highly susceptible cultivars (IR > 0.81). The cultivars characterized by slower development of the disease in the field conditions, i.e. those having the high and medium IR, were selected for laboratory experiments.

Parameters of quantitative resistance to *Septoria tritici* pathogen (latent period and size of infectious spots) were studied in 39 wheat samples, and those to *Stagonospora nodorum* — in 60 wheat samples. The susceptible Priokskaya cultivar was used as a control. The pathogen strains were obtained from the National Collection of phytopathogenic microorganisms and varieties of plants identifying pathogenic strains of microorganisms (ARRIP).

The selected plants were grown in artificial climate chambers till the 3rd leaf fully unfolded. A leaf was cut into 9-10 cm long pieces and placed in trays onto filter paper wetted with aqueous solution of benzimidazole (0.4 g/l). The pieces of leaves were inoculated by a drop of spore suspension of each of *S. tritici* isolates (V-35/ChI1, 5/23, 5/8, 5/9; 10^7 spores/ml) or *St. nodorum* isolates (R-8, V-81, V-28/KG_3, NAlt-1; 10^6 spores/ml), 10 replications per each variety-to-pathotype combination.

According to latent period and size of infectious spots, the varieties were grouped as follows: I — varieties with small infectious spots and long latent period; II — varieties with small infectious spots and short latent period; III — varieties with large infectious spots and long latent period; IV — varieties with large infectious spots and short latent period. The varieties with a long latent period included those for which it lasted for or longer than 15 and 5 days for *S. tritici* and *St. nodorum*, respectively, and the varieties with a short latent period included those for which it lasted for less than 15 and 5 days. Spots with the area of < 20 mm^2 were considered small, and those of > 20 mm^2 were referred to large ones.

Statistical processing was carried out by the analysis-of-variance method using the program developed at All-Russian Research Institute of Phytopathology (version 1.02.1995, № 006). Tables include mean values and LSD_{95}.

Results. Based on findings of multi-year research, wheat cultivars and hybrid forms derived from crossing of *T. aestivum* with *Aegilotriticum* sp. showing different rates of Septoria blotch development have been identified. The most long-lasting protection was provided by cultivars with the high index of resistance (i.e. partially resistant to the disease) characterized by slower development of Septoria blotch under field conditions.

Wheat cultivars with the high IR were selected from various genetic groups taking into account their origin. As a result, the studied samples were distributed into 10 ecology-geographical groups according to N.I. Vavilov's classification [30, 31].

The maximum number of samples (85.7 %) with the high index of resistance was identified in cultivars of *T. aestivum* subsp. *aestivum* (Table 1).

The majority (34.5 %) of the studied hexaploid wheat cultivars that demonstrated resistance originated from the North American ecogeographical group (species *T. aestivum* subsp. *aestivum*): high IR was characteristic of 77 varieties from the USA and 18 ones from Canada (see Table 1). They were mainly selection samples, as well as cultivars Chaparral, Minnpro, Anderson (the USA) and Agatha (Canada). Anderson and Agatha cultivars which demonstrated the high IR to Septoria blotch for 3 and more years of studies were of particular interest.

1. Wheat cultivars from the collection of the Germplasm Resources Information Network (GRIN, the USA) with the high index of resistance to Septoria blotch (infection nursery, Central Region of Russia, Moscow Province, 2009-2015)

Ecogeographical group	Country	Number of cultivars	Name
		Triticum aestivum subsp. *aestivum* (2*n* = 42)	
North American	USA	77	N No. 1226; N No. 1121; N No. 1265; Rival; N 1827; II-36-67; 1415 A-1-1-1-1; Ns. 3880.227; Ns. 3880.127; II-52-238; ND 364; Chaparral; II-56-10; II-54-89; II-54-102; II-54-1; II-58-51; II-60-115; II-59-11; II-62-51; II-62-48; II-62-15; II-62-69; II-62-65; II-62-76; II-62-77; II-62-79; II-62-75; II-62-82; II-62-81; II-62-83; II-62-84; II-62-25; II-54-79; II-62-49; II-62-32; II-62-31; II-60-222; II-61-1; II-61-15; II-62-71; II-60-220; II-60-218; II-62-72; II-62-35; II-62-20; II-54-46; II-56-32; II-56-29; II-56-33; II-58-15; II-58-57; II-58-14; II-56-12-7; II-60-100; II-60-46; II-60-126; II-60-130; II-52-324; CI 15756; ND 466-2; ND 468; Frohberg 12-107; MN 6796; MN 6864; MN 6955S; MN 6983S; MN 7570; ND 573; ND 599; MN 7444; MN 7533; ND 617; Minnpro; Cltr 15645; Anderson; WA 6101
	Canada	18	RL 988; RL 2520; RL 4137; Agatha; RL 4110; RL 4151; RL 4170; RL 4203; RL 4204; 60 GRR 92; Q 254-43; Q 2331-34; RL 6003; RL 6005; RL 6008; RL 6009; RL 6010, P8917-B4D4
Central American	Mexico	36	CI 2817; II-1776-2C; II-3962-2H-2Y-3C-1Y; VI-136-49-6H-1R; Huamantla Rojo; II-7242-5C-1H-2R-1M; II-7232-17R-1M-1B-2M; II-7527-5M-2R-5M-1R; II-7740-26-2H-1R-4M; II-8192-2R-2M-1R-4M; II-8495-4Y-9C-2Y-2C-1Y-2C-1Y; II-8523-11M-1R-4M; 8738-4R-5M-1R-1M-1R; P-9897-8T-2B-1T-1B; P-9916-9T-1B-2T-1B; P-11380-1B-7T-1B; P-11380-1B-7T-1B; II-11996-4R-5M-1R; JARAL 66; Bajio; Potam 70; II-19008-52M-6Y-3M-3Y-2C; II-19005-23M-3Y-3M-2Y-2C; II-19865-58M-100Y-104C; II-19021-4M-3Y-102M-2C; II-19008-83M-4R-4C-2Y-4C; D 19329-28M-11Y; Alondra 'S'; Cocora-Que F75; Mor 'S'; SWM 4127-1Y-1M-4Y-2M-1Y-OM; Bobwhite 'S'; Veery No. 3; Bobwhite 'S'; Alondra 'S'; II-1462-2C-2C-15C
	Brazil	8	BH 941; CNT 1; Trareano; 16-52-2, BH 2845; Itapeva; Colotano; 266/51
South American	Argentina	18	Americano; IF 1054; Klein H211-t-1422; Benvenuto Inca; Benvenuto 3085; La Prevision 25; 38 M.A.; Klein Lucero; Piamontes; D.I.V. 6656; I-1055; Magnif 142; Piamontes Inta; Klein Impacto; Vivela Mar; Taganrog Buck Balcarse; Mole II; 1352
	Peru	3	Mult 757; Mult 760; Mult 764
West European	Germany	1	Chinese 166
	Belgium	1	ALBA
	Macedonia	1	I/24
	Czechoslovakia	2	Dobrovicka Drogerowa B I 32; Stupicka Bastard
	Bulgaria	2	Bogdan, Experiment station no.85
	Portugal	3	Richelle Blanche Hative; Portugues; WS-9
East Asian	China	13	3867; CI 8328; Chiu mai; 7045; 7049; 848; 7177; 7227; 7329; I13; 357; ST-56; Daqingshan No. 4
Mediterranean	Turkey	1	1403
South-Western Asian	Iran	1	158e
	Afghanistan	2	BlackShanazi; Sirhosha
South Asian	Nepal	1	57-336
Australian	Australia	2	AB 21/10-1-1-2; Timson
African	Ethiopia	1	ELS 6404-26
Total		191	
		Triticum aestivum subsp. *spelta* (2*n* = 42)	
West European	Spain	1	69Z6.886
		Triticum turgidum subsp. *durum* (2*n* = 28)	
North American	USA	1	ND 63-36
	Canada	1	UM 6001

Table 1 (continued)

Central American	Mexico	6	RF 427-19; RF 427-30; Scoter 'S'; Gambridge 010, Pinguno 'S'; Pinguno
	Triticum turgidum subsp. *turgidum* ($2n = 28$)		
South-Western Asian	Armenia	1	37
West European	Portugal	1	Rubiao
	Triticum turgidum subsp. *dicoccon* ($2n = 28$)		
West European	Italy	1	Paganuzzi
	Spain	1	103
	Switzerland	1	Subletshchumicum
	Triticum timopheevii subsp. *timopheevii* ($2n = 28$)		
South-Western Asian	Georgia	1	WIR 38555
West European	Hungary	1	01.01.2004
Mediterranean	Israel	1	Kurazim
	Triticum monococcum subsp. *aegilopoides* ($2n = 14$)		
South-Western Asian	Iraq	3	G2292, G2706, G2885
West European	Hungary	1	1-1-1752
	Triticum aestivum × *Aegilotriticum* sp.		
North American	USA	2	SW34
Central American	Mexico	9	BW27722; BW27723; BW27777; BW27778; BW27779; BW27830; BW27985; BW28153; BW28154
Total		223	

The Central American group included cultivars from Mexico and Brazil. Among Mexican samples we have selected 36 cultivars having high IR. Slower development of the disease in the samples originated from Brazil (BH 941, CNT 1, Trareano, 16-52-2, BH 2845) was noted throughout multi-year studies. Eighteen cultivars with the high IR from Argentina and three lines from Peru have been identified among 54 studied samples from South America. Ten similar cultivars have been found out in West European countries, and 13 samples from China have been revealed in the East Asian ecogeographical group (see Table 1).

The Mediterranean, South-Western Asian, South Asian, Australian and African ecogeographical groups appeared to be represented by a small number of *T. aestivum* subsp. *aestivum* cultivars. However, we succeeded in finding samples with high partial resistance to the disease among them, i.e. sample 1403 (Turkey), 158e (Iran), Black Shanazi and Sirhosha (Afghanistan), 57-336 (Nepal), AB 21/10-1-1-2 and Timson (Australia), ELS 6404-26 (Ethiopia). In the genetic group of hexaploid wheat, sample 69Z6.886 (Spain) referred to *T. aestivum* subsp. *spelta* species has been selected (see Table 1).

Among tetraploid wheat cultivars of *T. turgidum* subsp. *durum*, we have revealed 16 ones having the high IR (originating generally from North and Central America). Two European samples were identified in *turgidum* subsp. *turgidum* group, three European samples were found among *T. timopheevii* subsp. *timopheevii* forms, as well as three ones — among *T. turgidum* subsp. *dicoccon* (see Table 1).

Cultivars with high index of resistance to Septoria blotch included 4 diploid wheat samples of *T. monococcum* subsp. *aegilopoides* originated from Iraq and Hungary. Slower development of the disease was also characteristic of synthetic lines of wheat from USA and Mexico (see Table 1).

When assessing the quantitative resistance of wheat cultivars to Septoria blotch pathogens *S. tritici* and *St. nodorum*, the samples were divided into four groups. Group I cultivars, the slower development of the disease in which is defined by a longer latent period and smaller size of infectious spots as compared to those in the susceptible control, attract the most interest for selection. Among the studied samples from the GRIN collection, we have not found any cultivars belonging to group I by their resistance to *S. tritici*. Group I by resistance to *St. nodorum* included 13 cultivars (Table 2).

The infection development in group II cultivars was slowed down due to the reduction in sizes of infectious spots. Group II by resistance to *S. tritici* included 8 cultivars, and by resistance to *St. nodorum* there were 8 cultivars as well from the GRIN collection (see Tables 2, 3).

2. Wheat cultivars from the collection of the Germplasm Resources Information Network (GRIN, USA) partially resistant to *Stagonospora nodorum*

№ as per the GRIN catalog	Cultivar	Origin	Spot size, mm^2	Latent period, days
		Group I		
PI 520555	Alondora 'S'	Mexico	18.32	7.00
PI 422413	CNT 1	Brazil	13.86	6.50
VIR 63915	Flame	Great Britain	15.72	6.50
PI 404115	Timson	Australia	12.03	6.25
PI 494096	Tadinia	USA	13.35	6.25
PI 168724	Benvenuto	Argentina	11.60	5.50
PI 306551	2944	Romania	13.30	5.50
PI 355706	69Z5.715	Azerbaijan	13.70	5.50
Cltr 15645	II-62-4	USA	16.56	5.50
PI 344468	Piamontes Inta	Argentina	16.88	5.50
Cltr 17904	Owens	USA	17.13	5.50
PI 355560	SK 1B	Switzerland	10.60	5.30
PI 94743	290	Russia	12.15	5.25
		Group II		
PI 190974	Aristato Blanco	Italy	11.00	4.50
PI 191353	Novokrymka 204	Ukraine	15.20	4.50
PI 341803	WIR43065	France	15.50	4.50
PI 345242	241-VII/4	Macedonia	12.90	4.30
PI 300991	Kurazim	Israel	13.40	4.30
PI 427867	G2697	Iraq	12.83	4.25
PI 418584	WIR 38555	Georgia	18.40	4.00
PI 290518	01.01.2004	Hungary	19.13	4.00
		Group III		
Cltr 12536	Anderson	USA	33.50	7.30
VIR 64130	Warigal Dagger	Australia	36.50	7.30
PI 168725	Benvenuto 3085	Argentina	48.00	7.30
PI 338913	Azteca	Mexico	66.40	7.30
PI 168724	Benvenuto INCA	Argentina	56.50	6.80
PI 278222	Gambridge Rivet	Great Britain	29.00	6.50
PI 604225	KS96WGRC40	USA	29.10	6.30
Cltr 13113	Kansas № 26365	USA	42.20	6.30
Cltr 15378	Piamontes	Argentina	24.58	6.25
Cltr 14465	Kansas № 594-2	USA	34.00	6.00
Cltr 14492	Azteca	Mexico	22.16	6.00
PI 214401	Veranopolis	Brazil	33.67	6.00
PI 520552	Bobwhite 'S'	Mexico	28.66	5.50
Cltr 12053	Cadet	USA	30.58	5.50
PI 422273	Alondra 'S'	Mexico	24.28	5.50
Cltr 11765	Chinese 166	Germany	39.28	5.50
PI 348702	69Z6.886	Spain	26.68	5.00
PI 479692	K-20	Republic of South Africa	35.00	5.00
Cltr 64135	IW 562	Australia	52.00	5.00
LSD_{95}			13.86	0.92

N o t e. Laboratory testing results. The groups are described in the *Technique* section.

3. Wheat cultivars from the collection of the Germplasm Resources Information Network (GRIN, the USA) partially resistant to *Septoria tritici*

№ as per the GRIN catalog	Cultivar	Origin	Spot size, mm^2	Latent period, days
		Group II		
Cltr 15378	Piamontes	Argentina	20.00	14.50
PI 433753	Gambridge 010	Mexico	16.60	8.00
PI 648860	BW 28154	Mexico	18.30	8.00
PI 191204	Rubiao	Portugal	13.50	7.75
Cltr 11765	Chinese 166	Germany	11.50	7.25
PI 189631	Trareano	Brazil	12.90	7.75
PI 352061	Klein Inpacto	Argentina	15.00	7.25
PI 422413	CNT 1	Brazil	14.00	7.00
		Group III		
PI 338913	Azteca	Mexico	25.00	15.00
PI 520555	Alondora 'S'	Mexico	36.30	15.00
LSD_{95}			21.10	1.94

N o t e. Laboratory testing results. The groups are described in the *Technique* section.

Group III included the cultivars that provided slower development of the disease due to longer latent period. Cultivars Azteca and Alondora 'S' belonged to them by resistance to *S. tritici*, and 19 cultivars were included due to resistance to *St. nodorum* (see Table 2). Susceptible cultivars, the latent period and size of infectious spots in which were consistent with or exceeded the similar parameters in the susceptible control, were referred to group IV. This group included 30 forms that demonstrated weak susceptibility to *S. tritici* pathogen in field experiments, and 20 forms showed weak susceptibility to *St. nodorum*.

Thus, as a result of multi-year studies of samples from the GRIN collection (Germplasm Resources Information Network, USA), wheat cultivars ensuring partial resistance of plants to Septoria blotch due to the extended latent period and reduced size of infectious spots, as well as capable of limiting the epiphytotic development of the disease, have been selected. They include 10 cultivars partially resistant to *Septoria tritici* pathogen, and 40 cultivars partially resistant to *Stagonospora nodorum*. The varieties most valuable for selection of cultivars with a durable resistance to Septoria blotch are Tadinia (PI 494096), Owens (Cltr 17904), II-62-4 (Cltr 15645) originating from the USA, Flame (VIR 63915) from Great Britain, Azteca (Cltr 14492), Alondora 'S' (PI 520555) from Mexico, Timson (PI 404115) from Australia, Chinese 166 (Cltr 11765) from Germany, CNT 1 (PI 422413) from Brazil, Benvenuto (PI 168724), Piamontes (Cltr 15378), Piamontes Inta (PI 344468) from Argentina, 2944 (PI 306551) from Romania, 69Z5.715 (PI 355706) from Azerbaijan, SK 1B (PI 355560) from Switzerland, and 290 (PI 94743) from Russia.

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