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PHYSIOLOGICAL SPECIALIZATION IN *Puccinia striiformis* AND GENES CONDITIONING RESISTANCE TO YELLOW RUST DISEASE IN CERTAIN WHEAT CUTLIVARS IN EGYPT

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ABSTRACT

The annual survey of wheat yellow rust races in 2002/2003 growing season resulted in the presence of 10 physiological races of *Puccinia striiformis* West. f. sp. *tritici*. Races 198 E 150 and 198 F 148 were the highest virulence on some Yr's resistance genes (differential varieties). On the other hand, race OEO was avirulent on all differential varieties (Yr's resistance genes). Probable yr7 resistance gene found in five tested commercial wheat varieties i.e. Sakha 8, Sakha 93, Sakha 94, Giza 170 and Sids 4. Also, Yr SU postulated to be found in two tested wheat varieties i.e. Sakha 93 and Giza 170. On the other hand, Sakha 69, Giza 160, Giza 168, Gemmeiza 9 and Sids 1 probably lack Yr's resistance genes from tested near-isogenic lines. However, postulation that Yr 7 exhibited the highest frequency (41.6%) followed by Yr SU (16.6%), Yr 6, Yr 8, Yr 2+ (8.3%) for each. On the other hand, Yr 7+, Yr 3N, Yr CV, Yr SP, Yr SD and Yr 9+ were not represented in the tested near-isogenic lines. Many of the cultivars studied can be combined into groups on the basis of sharing the same genes for resistance. Some cultivars probably have Yr 7 and/or Yr SU and other cultivars contained Yr 8. It is likely that most of these cultivars have genes in addition to those determined by this method as well as genes for adult plant resistance.

INTRODUCTION

Wheat stripe rust is one of the recent problems of wheat in Egypt, where it was formerly known as sporadic, but has been recorded annually since the early 1990's. The first yellow rust epidemic was recorded in 1967; however during the 1990's, three major epidemics were recorded in 1995, 1997 and 1999. Sporadic infections were observed during the other years (Abd El-Hak *et al.*, 1972, El-Daoudi *et al.*, 1977, Abu El-Naga *et al.*, 1999). The Most important yellow rust epidemic occurred in 1995 particularly in the Northern and Southern Delta areas and slight infections were also recorded in Middle and Upper Egypt. Yields of most of the popular commercial cultivars (Gemmeiza 1, Giza 157, Giza 163, Giza 164, Giza 165, Sakha 8, Sakha 69 and Sakha 92) were significantly reduced by stripe rust. A wide range of virulence pathotypes is evolving in Western Asia where cool and humid wheat growing areas, causing failures of resistance of widely-grown wheat cultivars. Therefore, surveys of *P. striiformis* pathotypes are important and provide valuable information to the breeding programs (Hakim *et al.*, 2001). The objectives of this study were to identify physiologic races in Northern Governorates in Egypt, probable resistance genes for stripe rust near-isogenic lines, frequency of the Yr's genes within commercial wheat cultivars and postulated common gene between the commercial cultivars. This study may serve the Egyptian breeding program in depth.

MATERIALS AND METHODS

The present work was carried out at Sakha Agricultural Research Station under greenhouse conditions at seedling stage in 2002/2003.

The collected rusted samples were purified using single pustule technique and multiplied on one or more of the following susceptible checks i.e. Little club, Giza 160, Gemmeiza 1, Giza 163, Sakha 8, Sakha 69, *Triticum spelta saharense*, *Triticum dicoccum tricoccum*, Baart and Michigan amber.

Eight day-old seedlings of the previously mentioned cultivars were gently atomized with sterile distilled water, rubbed between fingers in the presence of water plus few droplets of adhesive material such as tween 20, to remove the waxy layer on leaf and to increase the viscosity of the leaf surface aiming to preserve more urediniospores on the leaf blade according to the method adopted by Stakman *et al.* (1962) and added to the method mentioned by Rowell (1957) and Stubbs (1988) in which uredospores were suspended in mineral oil (mobile 100) or nonophotoxic paraffiinic oil i.e. Soltrol.

The inoculated plants were incubated in humid apparatus covered with a glass plate at 10°C for 24 hr and then placed in growth chamber at a diurnal temperature cycle that gradual changed between 15°C at a.m. and 18°C at p.m. The light period consisted of daylight supplemented with metal halide lights to extended the duration of light to 16 hr and the darkness to 8 hr. The supplemented light with fluorescent tubes gave light intensity of 7500 Lux according to Stubbs (1988).

A method of Statler (1984) was used to determine the probable resistance genotypes of the Egyptian commercial wheat varieties studied. For each pair of hosts studied, the infection types for the 10 races were classified into four categories according to the following scheme.

		Host B (unknown)	
		Resistant	Susceptible
Host A	Resistant	RR	RS
(known)	Susceptible	SR	SS

The HIT*: LIT** and LIT: HIT infection types are most critical to determine probable resistance genotypes. The four categories were based on presence or absence of these infection types as follows:

Category 0 = absence of LIT: HIT cultures indicating that host B has the same gene(s) as in host A, however host B may have additional resistance genes.

Category – : No HIT: LIT cultures but some LIT: HIT cultures indicating that host B does not contain the resistance genes in host A.

Category – 0: No HIT; LIT cultures and no LIT: HIT cultures indicating that both hosts carry the same resistance genes at least for resistance to the cultures used.

* HIT = High infection type.
** LIT = Low infection type.

Category +: Some HIT: LIT cultures and some LIT: HIT cultures indicating that hosts do not carry the same resistance gene(s).

Type of disease infection was recorded as the method adopted by Chen and Line (1992) using 9 classes from 0 to 9 where from 0-3 were resistant (R), 4 was moderately resistant (MR), 5-7 were moderately susceptible (MS) and 8-9 were susceptible (S).

In the case of dealing with the nomenclature of the Yr genes included in the commercial cultivars i.e. (having unknown genes = host B) that were compared with the Yr monogenic lines = host A that are known to have certain genes. but owing to the inavailability of stripe rust near-isogenic lines and the problem of winter wheat vernalization in the differentials we were obligated to be the adequate with the second part of Statler (1984) comparisons i.e. the comparison between the tested commercial cultivars in all the possible combinations utilizing the high infection type and low infection type comparisons against the tested seedling cultures. However, the common genes between cultivars, the other genes presented in a cultivars and not presented in the other and genes not presented in each pair of cultivars could be determined. The method helps to gain information about resistance genes which can be confirmed, if necessary by genetic analysis.

RESULTS

Data presented in Table (1) revealed the presence of 10 physiological races of stripe rust (*Puccinia striiformis* West. f. sp. *tritici*) which were identified on 17 differential cultivars i.e. 198 E 150, 198E 148, 70 E 182, 70E 96, 70E 20, 38E 72, 6E 24, 4E 180, 4E 16 and OEO.

Races 198E 150 and 198E 148 were virulent to Yr7, Yr6, YrSU and Yr 9+ form the world set; also they were virulent to Yr 6+, Yr8 and Yr2+ but the first race also was virulent to Yr 7+ form the European set.

Races 70E 182 and 70 E 96 and 70E 20 were virulent to Yr7, Yr6, YrSU from the world set; the first race was virulent to Yr 7+ Yr6+, Yr8 and 2+; the second race was virulent to Yr CV and YrSP and the third race was virulent to Yr 6+ and Yr8 from the European set.

Race 38E 72 was virulent to Yr 7, Yr 6 and Yr SD from the world set and Yr 3 N and Yr SP from European set. Race 6E 24 was virulent to Yr 7, Yr 6 from the world set and Yr 3 N and Yr 8 from the European set.

Finally, races 4 E180 and 4 E 16 were virulent to Yr 6 from the world set while the first race was virulent to Yr 6+, Yr8, Yr CV, Yr2+ and second race was virulent to Yr8 form the European set. Resistance genes possessed by respective cultivars were considered an ineffective against designated races that possessed virulence for them.

The presented data in Table (1) showed that only one culture out of ten was (OEO) avirulent on all of differential cultivars (near-isogenic lines), so it could not accurately hypothesized genes form these near-isogenic lines. Also, none of the cultures were virulent (HIT) on Yr 4+, Yr 1, Yr 3 V, Yr 10 and Yr 5 and none of the cultures avirulent (LIT) on Yr 6 except race OEO which was omitted. Therefore, these six genes could not be detected in the Egyptian commercial wheat cultivars.

Table (1): Seedling reaction of differential genotypes against yellow rust race identified in Egypt (2002/2003).

Races / Differential genotypes	European and world differential set										
	Yr gene	198 E150	198 E 148	70 E182	70 E 96	70 E20	38 E72	6 E 24	4 E 18	4 E16	OFO
Hybrid 46	4+	L	L	L	L	L	L	L	L	L	L
Reichersberg 42	7+	H	L	H	L	L	L	L	L	L	L
Heines Peko	6+	H	H	H	L	H	L	L	H	L	L
Nord Desperez	3N	L	L	L	L	L	H	H	L	L	L
Compair	8	H	H	H	L	H	L	H	H	H	L
Carstein V	CV	L	L	H	H	L	L	L	H	L	L
Spaldings prolific	SP	L	L	L	H	L	H	L	L	L	L
Heines VII	2+	H	H	H	L	L	L	L	H	L	L
Chinese 166	1	L	L	L	L	L	L	L	L	L	L
Lee	7	H	H	H	H	H	H	H	L	L	L
Heines Kolben	6	H	H	H	H	H	H	H	H	H	L
Vilmorin 23	3V	L	L	L	L	L	L	L	L	L	L
More	10	L	L	L	L	L	L	L	L	L	L
Strubes Dickkopf	SD	L	L	L	L	L	H	L	L	L	L
Suwon 92 x Omar	SU	H	H	H	H	H	L	L	L	L	L
Clement	9+	H	H	L	L	L	L	L	L	L	L
Triticum spella f. sp. *Album*	5	L	L	L	L	L	L	L	L	L	L

Data presented in Table (2) showed the performance of gene postulation in 12 Egyptian commercial wheat cultivars using 9 stripe rust physiological races against 11 wheat stripe rust near-isogenic liens. The matching between near-isogenic liens and commercial wheat cultivar against physiological races revealed that several of the comparisons had cultures with a LIT on the near-isogenic lines and a HIT on the host. This demonstrated the absence of that Yr gene in the host. Examples are those cultivars and near-isogenic lines with comparison type + in Table 2, e.g. Sakha 8 compared to Yr 8. Cultures in the HIT: LIT near-isogenic lines to commercial cultivar comparisons (comparison type + Table 2) indicated the presence of a gene other than the one in the comparison. Thus, most genes could be sequentially ruled out as occurring in a cultivar. It is obvious that Sakha 8 does not have genes listed in Table 2 other than Yr 7. Absence of cultures in LIT: HIT or LIT: HIT and HIT: LIT (category 0 or -0) comparisons indicated that the Yr gene could be presented in the cultivar listed in Table (2). Lack of cultures in LIT: HIT category in comparisons of Yr 7 with commercial cultivars indicated that five cultivars out of twelve studied probably have Yr 7. The cultivars that were hypothesized to have Yr 7 by this method can generally grouped together as sharing a common gene (Tables 2, 2A, 2B and 3 comparison type 0). Some of the cultivars probably have Yr 7 or Yr SU as indicated by the absence of cultures in LIT: HIT category in comparisons with these two near-isogenic liens. Absence of two cultures in the LIT: HIT category in comparison with Yr SU indicated that the two cultivars probably have Yr SU. Cultivars containing

Yr SU can be placed in another group which share the same gene (Tables 2, 2A, 2B and 3).

Data presented in Table (2A) showed the probably presented resistance genes for stripe rust near-isogenic lines in 12 Egyptian commercial wheat cultivars at seedling stage in greenhouse. Data revealed that the cultivars i.e. Sakha 8, Sakha 93, Sakha 94, Giza 170 probably have Yr 7 also, Sids 4 may be have the same gene(s), where Yr 7 has susceptible reaction to the same tested races.

Sakha 93 and Giza 170 probably have 2 genes i.e. were Yr 7 and YrSU. Gemmeiza 7 probably has 2 genes i.e. Yr 6+ and Yr 2. Sakha 61 was postulated to carry one gene i.e. Yr 8. On the other hand, Sakha 69, Giza 160, Giza 168, Gemmeiza 9 and Sids 1 probably did not have any genes of tested near-isogenic lines.

Data presented in (Table 2B) demonstrated the high frequency of identified Yr's genes within 12 Egyptian commercial wheat cultivars. Data presented showed that the Yr 7 near-isogenic line was the most frequent one (41.6%) followed Yr SU (16.6%) and Yr 6, Yr 8 and Yr2+ each one of them was represented by (8.3%). On the other hand, Yr7+, Yr 3N, Yr CV, Yr SP, Yr CD and Yr 9+ probably were did not represented in tested commercial wheat cultivars.

Table (2): Comparison of near-isogenic lines of yellow rust (Yr's) and 12 commercial cultivars inoculated with 9 races of *Puccinia striiformis* f. sp. *tritici* at seedling stage during 2002/2003 growing.

Commercial cultivars	Reichersberg 42 Yr 7+	Heines Peko Yr6+	Nord Desperse Yr 3N	Compair Yr8	Carsten V Yr CV	Spalding prolific Yr SP	Heins VII Yr2	Lee Yr 7	Strubs Dikkopf Yr SD	Suwon x Omar YrSU	Clement Yr 9+
Sakha 8	*-	+	-	+	+	+	+	0	-	+	-
Sakha 61	**+	+	+	0	+	+	+	+	+	+	+
Sakha 69	+	+	-	+	+	+	+	+	-	+	+
Sakha 93	-	+	+	+	-	+	-	0	+	0	-
Sakha 94	-	-	+	+	-	+	-	0	+	-	-
Giza 160	-	-	-	+	-	-	-	-	-	-	-
Giza 168	+	+	-	+	+	+	+	+	-	+	+
Giza 170	-	+	+	+	+	+	+	0	+	****-0	-
Gemmeiza 7	+	***0	+	+	+	+	0	+	+	+	+
Gemmeiza 9	+	+	+	+	-	+	+	+	+	+	+
Sids 1	-	+	-	+	+	-	+	-	-	-	-
Sids 4	-	+	-	+	+	-	+	-0	-	-	-

* - = Absence of cultures HIT: LIT category.
** + = Cultures present in LIT: HIT and HIT: LIT category
*** 0 = Absence of cultures in LIT: HIT category
**** -0 = Absence of cultures in the LIT: HIT and HIT: LIT category.

Table (2A): Probable resistance genes for stripe rust near-isogenic lines in 12 Egyptian commercial wheat cultivars at seedling stage in greenhouse in 2002/2003.

No.	Commercial varieties	Probable* Yr genes
1	Sakha 8	Yr 7
2	Sakha 61	Yr 8
3	Sakha 69	0
4	Sakha 93	Yr 7 and Yr SU
5	Sakha 94	Yr 7
6	Giza 160	0
7	Giza 168	0
8	Giza 170	Yr 7 and Yr SU
9	Gemmeiza 7	Yr 6+ and Yr 2
10	Gemmeiza 9	0
11	Sids 1	0
12	Sids 4	Yr 7

* Yr genes: Yellow rust resistance genes

Table (2B): The frequency of identified Yr's genes within 12 Egyptian commercial wheat cultivars at seedling stage in 2002/2003.

No.	Yr's* genes	No. of varieties carrying Yr genes	Frequency (%)
1	Reichersberg 42 Yr 7+	0	0
2	Heinspek Yr 6	1	8.3
3	Nord Desperse Yr 3N	0	0
4	Compair Yr 8	1	8.3
5	Carstein V Yr CV	0	0
6	Spalding prolific Yr SP	0	0
7	Heins VII Yr 2+	1	8.3
8	Lee Yr 7	5	41.6
9	Strubs Dikkopf YrSD	0	0
10	Suwon x Omar Yr SU	2	16.6
11	Clement Yr 9+	0	0

* Yr's: Yellow rust resistance genes

Data presented in Table (3) demonstrated the incidence of cultures in low infection type: high infection type comparison of cultivars inoculated with 9 races of *Puccinia striiformis* f. sp. *tritici.* Absence of cultures in LIT: HIT comparisons (category 0) or absence of cultures LIT: HIT and HIT: LIT comparisons (Category-0) indicated that the two cultivars compared share a common gene. Several of the cultivars have at least one gene in common as indicated by a lack of cultivars in LIT: HIT or HIT: LIT categories in comparisons among cultivars. Sakha 8 for example, probably has a gene which also occurs in Giza 160, Sids 1 and Sids 4. This gene is probably Yr 7, Table (2). Data presented in Table (3) showed that Sakha 8, Sakha 61, Giza 170 and Gemmeiza 7 probably did not have any genes for resistance. But the reciprocal reaction postulated the presence 3, 2, 4 and 6 common genes in such cultivars, this common gene probably was Yr7; Yr8; Yr7 or Yr SU and Yr 6 or Yr2, respectively.

Also, Sakha 69, Giza 160 and Sids 1 probably did not have any common gene for resistance. But, the reciprocal reaction showed the presence of 3, 8 and 4 common genes in their cultivars. This common gene did not identified in the tested near-isogenic lines, Table (2). Sakha 93 postulated to have one common gene with Gemmeiza 7 and reciprocal reaction indicated the presence of common gene with Sakha 94 and Giza 160, this common gene probably was Yr 7 or Yr SU, Table (2).

Table (3): Incidence of cultures in the LIT: HIT (low infection type: high infection type) comparison of cultivars inoculated with 9 races of *Puccinia striiformis* f. sp. *tritici*.

Cultivars	Cultivars											
	Sakha 8	Sakha 61	Sakha 69	Sakha 93	Sakha 94	Giza 160	Giza 168	Giza 170	Gemmeiza. 7	Gemmeiza. 9	Sids 1	Sids 4
Sakha 8		+	+	+	+	-	+	+	+	+	-	-
Sakha 61	+		-	+	+	+	+	+	+	+	-	+
Sakha 69	+	0		+	+	+	0	+	0	+	+	+
Sakha 93	+	+	+		-	-	+	+	0	+	+	+
Sakha 94	+	+	+	0		-	+	0	0	0	+	+
Giza 160	0	+	+	0	0		0	0	0	0	+	0
Giza 168	+	+	-	+	+	-		+	0	+	+	-
Giza 170	+	+	+	+	-	-	+		+	+	-	-
Gemmeiza 7	+	+	-	-	-	-	-	+		-	+	+
Gemmeiza 9	+	+	+	+	-	-	+	+	0		+	+
Sids 1	0	0	+	+	+	+	+	0	+	+		0
Sids 4	0	+	+	+	+	-	+	0	+	+	-	

0 = Absence of cultures in LIT: HIT, - = Absence of cultures HIT: LIT category, + = cultures present in LIT: HIT and HIT: LIT category, -0 = Absence of cultures in the LIT: HIT and HIT: LIT category.

Sakha 94 probably has 4 common genes with Sakha 93, Giza 170, Gemmeiza 7 and Gemmeiza 9, also reciprocal reaction indicated probably presence of one common gene with Giza 160. This common gene postulated was Yr 7 Table (2).

Giza 168 has postulated a common gene with Gemmeiza 7, and reciprocally reaction showed the presence of common gene with Giza 160. This gene was not identified in tested near-isogenic lines, Table (2). Gemmeiza 9 probably has one common gene with Gemmeiza 7 and reciprocal reaction showed common gene with Sakha 94 and Giza 160. This common gene probably did not detected in tested near-isogenic lines.

Finally, Sids 4 was postulated to have two common genes with Giza 160 and Sids 1, while reciprocal reaction was shown with 2 genes. This common gene may be Yr 7.

DISCUSSION

Yellow rust of wheat (*Puccinia striiformis* West. *f.* sp. *tritici*) is the most important wheat disease in cool and humid wheat growing areas (Stubbs, 1988, Johnson, 1988; Danial, 1994) and has become a major wheat disease in Western Asia since the late 1980's (Mamluk *et al.*, 1996). In Egypt the occurrence of such disease was not permanent especially during the few last decades. The presence of four critical periods of epidemic could be recognizable i.e. 1967/68, 1994/95, 1997/98 and 1999/2000. However, a little bet cases of infections were recorded during 1985 and 1998 (El-Daoudi *et al.*, 1996; Abu El-Naga *et al.*, 1997, 1998, 1999 and 2001). These epidemics were closely related to the affinity of the genetic constitutions of both the host and the pathogen or between the prevalent cultivars and the dominant races of yellow rust pathogen, and associated with the availability of the environmental conditions that favour the disease.

The obtained results gave evidence to the presence of 10 physiological races of *Puccinia striiformis* West. in Egypt in 2002/2003. Race OEO was recorded earlier at Saudi Arabia, Algeria, Morocco (1990-1992), Louwers *et al.* (1992) and in Egypt 1999-2000, Abu El-Naga *et al.* (2001) and Youssef *et al.* (2003). Race 198 E 150 is characterized by the high virulence, since it attacked Yr 9, Yr SU, Yr 6, Yr 7 from world set and Yr 2+, Yr 8, Yr 6+ and Yr 7+ from European set.

The present results gave evidence to the probable presence of Yr 7 resistance genes in 5 commercial wheat cultivars. Also, some commercial cultivars were postulated have 2 Yr's genes i.e. Sakha 93 has Yr 7 and Yr SU; Gemmeiza 7 has Yr 6 and Yr2. However, other cultivars likely include one gene i.e. Sakha 61 has Yr8. On the other hand, some cultivar probably have not any gene of the tested near-isogenic lines.

Regarding the comparisons between tested commercial wheat cultivars in all possible combination, the obtained results indicated that cultivars belong to the category (-0) was absence. On the other hand, the category (0) indicating that cv. Sakha 61 probably has common gene with Sakha 69 and Sids 1. This common gene was postulated as Yr 8. Sakha 93 probable has common gene with Gemmeiza 7. This gene was postulated as Yr 7 or Yr SU. Also, Sakha 94 has common gene with Sakha 93, Giza 170, Gemmeiza 7 and Gemmeiza 9. This gene probably designated as Yr 7. However category (+) indicating that both cultivars carrying genes not present in the other such as Sakha 8 and Gemmeiza 7. Category (-) indicated that the cultivar carrying at least two genes not present in two other cultivars. The presence of such resistance genes was postulated regardless of their nomenclature owing to the absence of identified physiological races of stripe rust in Egypt. This assumption was built in the response of the used commercial wheat cultivars against the so called stripe rust greenhouse cultures.

This results are accorded with Abu El-Naga *et al.* (2001), who mentioned that the commonly grown wheat cultivars in Egypt were varied in their resistance to yellow rust. Also, they confirmed the resistance of the new high yielding cultivars i.e. Giza 168, Sakha 61, Sakha 93, Gemmeiza 7, and Gemmeiza 9. The wheat cultivars Sakha 8 and Sakha 69 were, as expected susceptible to yellow rust and will not be recommended for further cultivation. These results is referred to postulate the presence of Yr 7 resistance gene in the cultivar Sakha 94. Also, these results were supported with Abu El-Naga *et al.* (2001) as they previously mentioned that the resistance of the cultivars could be attributed to the presence of resistance genes these have the same or similar action as Yr 1, Yr8 and Yr 7. Their suggestion is based on the observation that in adult plant stage none of the physiological races tested in Egypt could attack their genes. Similar results were recorded by Abd El-Hak *et al.* (1972), Abu El-Naga *et al.* (1997, 1998, 1999), Hakim and Ahmed (1998), Zwer and Qualset (1991). However, the resistant cultivars could be based on other genes or combinations of genes. The resistant lines could be useful for breeding programs for resistance to stripe rust in Egypt.

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التخصص الفسيولوجى لفطر بكسينيا سترابفورمس و جينات المقاومة الفعالة ضد مرض الصدأ الاصفر فى بعض أصناف القمح فى مصر

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أظهر الحصر السنوى لسلالات الصدأ الاصفر فى القمح فى مصر خلال موسم ٢٠٠٢/٢٠٠٣ وجود عشره سلالات فسيولوجيه من الفطر. السلالات 198 E 148 and 198E 150 كانت أكثرعدوانيه على بعض جينات المقاومة (الاصناف المفرقه) على جانب أخر كانت السلاله OEO غير عدوانيه على الاصناف المفرقة للصدأ الاصفر (غير عدوانيه على جينات المقاومة Yr's). إحتمال وجود جين المقاومة Yr7 فى خمسه أصناف قمح تجاريه مختبره وهى على سبيل المثال سخا ٨ ، سخا ٩٣ ، سخا ٩٤ ، جيزه ١٧٠ ، سيدس ٤. ايضا YrSU احتمال وجود هذا الجين فى إثنين من أصناف القمح المختبره هى: سخا ٩٣ وجيزه ١٧٠. على جانب أخر فإن أصناف القمح سخا ٦٩ ، جيزه ١٦٠ ، جيزه ١٦٨ ، جميزه ٩ ، سيدس من المحتمل انها لا تحمل أى جينات مقاومة للصدأ الاصفر من جينات المقاومة المختبره. مع ذلك يفترض أن جين المقاومة Yr7 يمثل (٤١,٦%) فى التكرار يليه YrSU حيث يمثل (١٦,٦%) ، Yr6, Yr7+, Yr3N, Yr 8 and Yr2+ كل جين من هؤلاء يمثل حوالى (٨,٣%). من ناحية أخرى CV, Yr SP, Yr SD and Yr9+ غير ممثله فى السلالات احاديه الجين المختبره. عديد من الاصناف المدروسه يمكن اتحادها فى مجاميع على اساس مساهمه نفس الجينات من أجل المقاومة. احتمال ان بعض الاصناف تملك Yr7 او YrSU وصنف اخر يشمل Yr8. احتمال ان معظم الاصناف تملك جينات بالاضافة الى هؤلاء الاصناف التى تم تقديرها بهذه الطريقة مثل الجينات من أجل النبات البالغ.