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# Poster Abstracts

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# Table of contents

## Poster Abstracts

# Theme 2: National Efforts to Breed for Rust Resistance

## 32 Seedling and adult plant resistance to stem rust race Ug99 in spring wheat landraces

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New sources of stem rust resistance are needed to help manage race Ug99 (TTKSK and its variants). Adult plant resistance (APR), as opposed to all-stage resistance, is typically not detected in greenhouse seedling tests. Spring wheat landraces from the USDA-ARS National Small Grains Collection are being screened for resistance to Ug99 in the field at the Kenya Agricultural Research Institute, Njoro. Accessions showing field resistance are screened for seedling resistance to TTKSK at the USDA-ARS Cereal Disease Laboratory. Given adult and seedling data, it is possible to determine the frequency of APR as well as the strength of the association between adult field and seedling greenhouse test results. To date, 227 landraces have been screened as seedlings and 403 are in current tests. Twelve of 227 accessions (5%) showed field resistance and seedling susceptibility to TTKSK. Of these, four were positive for marker *csSr2* associated with *Sr2*, the only stem rust APR gene presently described. Accessions with *Sr2* may not be landraces. The eight accessions negative for *csSr2* may possess uncharacterized APR genes. The hypothesis that seedling scores are correlated with field responses was tested by converting seedling and field data to ordinal categories (7 and 15 groupings, respectively). Resistance ratings at the different growth stages were significantly related (Spearman's coefficient = 0.39, $p = 1.7*10^{-9}$), even when data for the 12 APR accessions were included. The hypothesis that seedling scores are predictive of field resistance will be tested again with the complete data set.

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## 33. Resistance to stem rust in Australian barley cultivars

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Stem rust, caused by *Puccinia graminis* f. sp. *tritici* (*Pgt*), is one of the most devastating pathogens of cereals worldwide. In Canada and the Northern Great Plains of the U.S.A., the wheat stem rust fungus has caused a number of significant epidemics on both wheat (*Triticum aestivum)* and barley (*Hordeum vulgare*). Although stem rust has not been a major problem on wheat and barley in the U.S.A. for over four decades, it is still considered the most destructive of the cereal rusts. Resistance in barley was largely achieved by the widespread use of a single resistance gene (*Rpg1*). In North America, *Rpg1* provided resistance to stem rust from 1942 and remained effective until the appearance of race QCC in 1989. It is also ineffective against race Ug99. Little is known about the genetics of resistance in Australian barleys to *Pgt*; most cultivars exhibit moderately susceptible seedling responses to Australian races of *Pgt*. Marker analysis confirmed the presence of *Rpg1* in Australian cultivars 'Yerong', 'Empress', 'Vlamingh' and 'Pacific Ranger'. Multipathotype seedling tests using selected North American races confirmed the presence of *Rpg1* in these cultivars. In addition to *Rpg1*, 'Pacific Ranger' is hypothesized to carry *rpg4*. The cultivars 'Franklin' and 'O'Connor' did not amplify the *Rpg1* marker, but were resistant in multipathotype tests, suggesting that they may have additional genes for resistance. Data from a DH 'Yerong'/'Franklin' population tested with race MCC indicated that 'Franklin' has a single dominant gene for resistance.

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# 34. Resistance to stem rust race Ug99 in selected wheat germplasm

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Race Ug99, or TTKSK, of *Puccinia graminis tritici*, causing stem or black rust on wheat (*Triticum aestivum*), has been recognized as a major threat to global wheat production as the pathogen has virulence for a number of important resistance genes. New variants of the UG99 lineage with virulence to *Sr24* and *Sr36* indicates that the pathogen is continuing to evolve; they have rendered more than half of the previously known Ug99-resistant wheat germplasms susceptible. Identifying and characterizing new sources of resistance within breeding materials, commercial cultivars and related species will ensure future genetic diversity. A study was carried out at KARI (Kenya Agricultural Research Institute), Njoro to identify sources of resistance to stem rust. Twenty-five wheat lines selected from previous wheat screening nurseries (2008) carry both seedling and adult plant resistances to stem rust. Five resistant wheat lines, including CWANA 1st SR RESIS. ON-ETH-OS71, MON'S'/ALD'S'//TOWPE'S', THELIN#2/ TUKURUCGSS02Y 00118S-099M-099Y-099M-16Y-OB, PBW343*2 /KUKUNA //PBW343*2 /KUKUNA /3/ PB W343, and SUNCO//TNMU/TUI, R07F4-21258, and the susceptible parent, CANADIANCUNNINGHAM//KENNEDY were crossed in a partial diallel to develop populations for studying the genetics of resistance. Mapping studies will be conducted to identify and characterize genes for resistance. The wheat lines exhibited varied rates of disease progression. Further studies are focusing on combining genes for stem rust resistance, while introgressing the resistance genes into high yielding Kenyan backgrounds. These elite lines will form the basis for durable resistance in wheat breeding programs to avert further yield losses.

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# 35. Collaborative research against ug99 in wheat-BARs-09 a success story

***M. Tariq[1], M. Ijaz[2] and A. Afzal[3]***

Wheat is the most important food crop and the major component of our research programme at Barani Agricultural Research Institute (BARI), Chakwal, Pakistan. Among various biotic stresses rusts pose a constant danger to sustainable wheat production in all wheat growing countries including Pakistan. To identify resistant sources screening of wheat material is being conducted in Kenya and Ethiopia by CIMMYT and ICARDA, and shuttle breeding schemes are used to enhance the selection of new high yielding wheat lines. Under this collaborative study BARI has evolved a high yielding (4917 metric ton/h) and moderately stem rust resistant (5MR to 15MSS and marked as 1st choice) variety BARS-09 against Ug99 a global food security threat. BARS-09 with parentage PFAU/SERI//BOWS, originally an exotic genotype, has been developed through selection process and screened at Kenya. It is a semi dwarf, medium duration genotype and showed good performance under moisture conditions. It showed frost tolerance under field conditions. It has good chapatti quality. It holds resistant gene *Sr2* against stem rust confirmed through 83 bp PCR amplification DNA of stn 5S9tgag (*Sr2* primer). Protection of world wheat through evolving genotypes like BARS-09, with new sources of durable resistance to Ug99, can be attained by using all the techniques known, by watching closely the evolution and migration of new races of rust fungi, and by utilizing conventional breeding, molecular breeding or any other activity that makes efficient field screening such as monitoring and surveillance, shuttle breeding, gene pyramiding. The regional cooperation in collaborative research initiated recently in East Africa, i.e., group effort and sharing generated information, has proved momentous, and the technology is adopted to a large extent. Inland collaborative research at NARC, Islamabad, and BARI, Chakwal, indicates that BARS-09 is not only moderately resistant against stem rust and leaf rust but also has resistance against stripe rust with 5MR response at Kenya and at various locations in Pakistan.

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## 36. Status of Rust Resistance in Indian Wheat Cultivars

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India is the second largest producer of wheat in the world. During the 2009-10 cropping season 80.70 million tonnes were harvested from 28.5 m ha. Among several biotic stresses, the most important are the three rusts. Leaf or brown rust is important throughout the country. Management of the rusts mainly focuses on host resistance. No variety is recommended for release or cultivation unless it carries an adequate level of resistance. Data from rigorous screening of the germplasm and breeding materials at 'hot spot' locations, and under artificial epiphytotics, are the basis for cultivar approval and recommendation. When new pathotypes emerge, and old varieties become susceptible, re-evaluation against the new and prevalent races is a recurrent process. Recommended varieties for the Central and Peninsula Zones must have high degrees of resistance to stem rust and leaf rust, whereas those for the North Western Plain and Northern Hills Zones must have resistance to stripe rust and leaf rust, and those for the North Eastern Plain Zone must carry resistance to leaf rust. Various aspects of resistance in popular cultivars and advanced breeding lines, the resistance genes involved, and prevalent pathotypes, will be discussed.

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## 37. Breeding strategies to improve tolerance in Indian wheat genotypes against leaf and stripe rusts to enhance productivity under global climate change

***G. Singh, M.S. Saharan, B. S. Tyagi and S. S. Singh[1]***

Wheat is one of the most important widely grown and consumed food grains all over the world. It is the staple food and main source of energy in Indian diet. The diverse environmental conditions and food habits supports the cultivation of three species of wheat viz; *T. aestivum*, *T. durum* and *T. dicoccum* in India. India has harvested record production of 80.70 million tons during 2009-10. Due to climate change, wheat may face biotic as well as abiotic constraints. Among biotic stresses, rusts are most important in India. Among rusts, leaf or brown rust occur in all wheat growing zones, while stripe or yellow rust is important in northern hill zone, north western plains zone and north eastern plains zone. During 2000-01, prominent wheat variety 'PBW 343' became susceptible to yellow rust and by the year 2008-09, disease started appearing in severe form in few pockets in Punjab state. During 2010-11, disease showed its presence in wide areas covering Punjab, Haryana and J&K. The Indian wheat programme has been successful in managing rusts by developing resistant varieties against new pathotypes. Besides, a large number of genetic stocks carrying resistant genes in different backgrounds were developed and utilized in breeding programmes across the country. Some of the newly registered genetics stocks like FKW 1, FKW2, FKW 3 and FKW 4 that carry genes from even tetraploid species (*T. durum*) are very promising and can be used as the donors. Keeping in view the narrow genetic base for resistance to stripe and leaf rusts in Indian genotypes, there is a need to strengthen the pre-breeding efforts using synthetics, wild relatives and proven sources of resistance for ensuring national food security.

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# 38. Identification of slow ruster wheat genotypes for stripe and leaf rusts under artificially inoculated conditions

*M. S. Saharan[1], A. K. Sharma[1], S. S. Singh[1] and M. Singh[1]*

In the present study, a set of 241 Indian wheat genotypes (advance lines and popular cultivars) was evaluated with prevalent stripe rust (78S84, 46S119) and leaf rust (12-2, 77-2, 77-5, 104-2) pathotypes under artificially inoculated conditions at Directorate of Wheat Research, Karnal (Haryana) during 2009-10 crop season to identify slow ruster genotypes. Genotypes were categorized into distinct groups based on the Area Under Disease Progress Curve (AUDPC) values calculated from the rust intensities recorded at an equal interval. Among AVT-2nd year lines (105), 30 genotypes were found free from both rusts. Out of 241 lines, 148 were found free from stripe rust. Among rest of genotypes, 23, 10, 32 and 23 lines were categorized into group-II (AUDPC: 1-100), III, (AUDPC: 101-200), IV(AUDPC: 201-500) and V, (501-1000), respectively. Group III (HD 2781, HI 977, HS 375, K 0307, KRL 240, MP 4106, PBW 590, WH 1081, MP 1237, AKAW 4210-6) and IV (HD 2733, HD 2932, HS 295, MACS 2971, MP 3288, NW 2036, PBW 175, UAS 316, UP 2744, VL 829, WH 1081, WHD 943, DBW 59, HS 521, HS 532 & PBW 639) genotypes were characterized to be slow ruster as their AUDPC values was less than 20 % of the checks. Likewise for leaf rust, genotypes were placed in group-II (21 genotypes), group-III (9 genotypes) and group-IV (16 genotypes), respectively. Group III genotypes (GW 322, HD 2781, HI 977, KRL 213, MACS 3742, PBW 343, PDW 233, HD 3037 & VL 945) showed slow ruster response for leaf rust.

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# 39. The national wheat breeding program for development of high yielding and rusts resistant of bread wheats for Tajikistan

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Wheat is the main staple food crop in Tajikistan and it is of high importance to have an in-country breeding program in collaboration with International Centers. In particular yellow rust has become a serious wheat disease, and significantly reduced grain yield by 30-50% in Tajikistan in 2010. The breeding activities carried out by the national wheat breeding program in 2009 and 2010 has resulted in a number of high yielding and yellow rust resistant facultative/winter and spring bread wheat lines being identified through multi-location yield trials. The following lines were promoted for official variety testing; PRINIA/STAR, SHARK/F4105W2.1, OTUS/TOBA97, HUAYUNINIA, KAUZ*2/CHEN//BCN/3/MILAN, CBRD/KAUZ and CMH82A.1294/2*KAUZ//MUNIA/CHTO/3/MILAN.

The stem rust race Ug99 has spread across a number of African countries and have now established itself in the Middle East, and might migrate further. For this reason 100 widely grown bread wheat varieties and advanced breeding lines were evaluated for adult plant resistance against Ug99 at Njoro, Kenya. The results showed that 85% of the genotypes were susceptible with reactions ranging from 40S to 70S and 10% were found moderately susceptible ranging from 20MS to 50MS. Only 5% of the genotypes were found moderately resistant ranging from 10MR to 40MR to Ug99. Also, a number of BC1F3 wheat-rye translocation lines (1RS++ and 2RL-+) were evaluated for resistance towards Ug99 in Njoro, Kenya. Two lines showed APR to Ug99. The two resistant lines will be utilized in combination with Tajik germplasm to develop a mapping population for determining the underlying basis of resistance.

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## 40. Postulation of genes for adult plant resistance to leaf rust in wheat cultivars

***M. I. Kiseleva[1], E. D. Kovalenko[1] and H. Bockelman[2]***

In the breeding programs worldwide wheat genotypes with adult plant resistance (APR) to leaf rust are preferred as parents because they often provide durable disease control. Sixteen accessions of *Triticum aestivum subsp. aestivum* and 8 lines of synthetic wheat (*x Aegilotriticum sp.)* from the National Small Grains Collection, USDA-ARS, possessed APR. The goal of our research was to identify the genes for APR in those accessions by their specific reactions to selected *Puccinia triticina* isolates. Twelve isolate differing in virulences to a set of wheat lines with genes: *Lr12, Lr13, Lr22a, Lr22b, Lr34, Lr35* and *Lr37* were chosen. APR genes were postulated in 9 wheat accessions by the tests. Genes *Lr37* and *Lr13* were often present. APR in CM 23091-1M-2Y-0Y, Myna"S", and 11-1462-2c-2c-3c was conferred by these genes. The gene *Lr37* and an unknown gene was postulated in Moncho"S", Torim 73, ND 63-74. The genes *Lr13* and *Lr22b* were found in Pergamino, and Gaboto M.A.G., and genes *Lr12, Lr13* and *Lr22b* were identified in 11-1462-1c-1c-4c. Gene *Lr12*+ was determined in ND 460 and *Lr13* was in BW27858. Gene *Lr13* in combination with unknown genes was postulated in samples CASS97B000441S and CASS97B00054S. The combination of *Lr13* and *Lr22b* was present in sample CASS97B00046S. APR genes in several accessions could not be postulated because no pathotype was virulent to them.

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## 41. Strategy of wheat breeding for resistance to leaf rust in various regions of Russia

***E. D. Kovalenko, A. I. Zhemchuzhina, M. I. Kiseleva, T. M. Kolomiets[1]***

The strategy of breeding for resistance to leaf rust depends on the epiphytotic situations in each regios, type of wheat (winter or spring), and historic levels of infection. Leaf rust is widespread in all wheat regions of Russia. Long-term study of population structures has revealed the effectiveness of resistance genes and sources. Juvenile resistance genes: *Lr9, Lr24, Lr29, Lr38, Lr41, Lr42, Lr45,* and *Lr47* are effective in all regions. In order to prevent rapid loss of resistance new cultivars must not exceed 9-10 % of sown areas. Cultivars with APR provide more durable protection. Genes *Lr12, Lr13, Lr35, Lr37,* and *Lr22a* are the most effective in all regions. Gene *Lr37* confers resistance to all three rusts. Breeding for durable resistance is conducted in the following ways. For winter wheat cultivation regions (Northern Caucasus, Central, Central Black Earth) it is necessary to use the slow rusting and APR. This reduces infection being transferred from winter to spring wheats grown in the Volga region. In the Volga region it is necessary also to use wheats with APR and partial resistance. The resistance genotypes of spring and winter cultivars should be different. In Western and Eastern Siberia where spring wheats prevail it is possible to introduce race-specific resistance using various effective *Lr*-genes and their combinations.

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## 42. Identification of resistance to wheat stem rust race Ug99 in Iran

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Wheat stem (black) rust, caused by *Puccinia graminis* f. sp. *tririci,* can be an important disease in the north, west and south of Iran. Stem rust has been endemic in Iran for many years. A new race that appeared in Uganda (1998-1999) with virulence on gene *Sr31* will become a serious problem if it increases to become predominant and widespread in the CWANA region and other countries. In 2010, the presence of Ug99 was reconfirmed in parts of Khuzestan province located in southwest Iran. In the present work seedlings of 164 wheat genotypes were tested in the greenhouse at 22 to 24ºC against race Ug99 with avirulence/virulence formula: ***Sr6, Sr13, Sr22, Sr23, Sr24, Sr26+Sr9g, Srgt/*** *Sr7a, Sr7b, Sr8a, Sr8b, Sr9a, Sr9b, Sr9d, Sr9f, Sr9g, Sr10, Sr11, Sr12, Sr14, Sr15, Sr16, Sr17, Sr19, Sr20, Sr21, Sr25, Sr28, Sr29, Sr30, Sr31, Sr32, Sr33, Sr34, Sr35, Sr36, Sr37, Srtt3+Sr10, Srdp2, Srwld, SrH*. Infection types were recorded 12-14 days after inoculation. The objective was to record reactions when the difference between the susceptible controls was at the maximum. Stem rust infection types were recorded using the scale that described by McIntosh *et al.* (1995). Thirteen genotypes of bread wheat (including C-84.5517, C-85-D-13, M-87-16, S-83-3, and S-87-20) and 12 genotypes of durum (including D-81-6, D-82-6, D-84-3, D-85-5, and D-89-7) were resistant. To confirm resistance this group must be tested in the field with Ug99.

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## 43. Bioinformatics integration in breeding for rust resistance in wheat: prospects and challenges in Morocco

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Wheat is a strategic cereal crops in Morocco as well as a model plant with a complex genome. Moroccan breeding programs have produced many productive varieties suitable for most of the agro-ecological zones. Nevertheless, and especially in the north western regions of Morocco, rusts, particularly leaf rust, caused by *Puccinia triticina* limit profitability of the crop by causing yield and quality losses. Breeding for resistance to leaf rust is important for improving and stabilizing yield without having to use of chemicals. Since 2006, INRA has been establishing a platform for bioinformatics which will function together with conventional wheat breeding and will offer new approaches for dealing with agronomic traits, rust resistance and grain quality. This approach will play several roles in breeding for disease resistance since it will develop suitable markers to accelerate the breeding cycle using marker assisted selection. It will also allow the visualization of information from heterogeneous datasets to facilitate the selection of the best performing lines. Bioinformatics will therefore play an increasing role in integrating phenotypic and pedigree information for agronomic as well as resistance traits. Improved algorithms and increased computing power will make it possible to optimize selection strategies for combating rust epidemics. In the present paper, we will focus on the role of bioinformatics in wheat breeding programs and will present the approach used to develop molecular markers to characterize important agronomic trait and disease resistance loci, and to understand their evolution and application in wheat genetic improvement.

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## 44. Effective genes for wheat stem rust resistance at New Halfa, Sudan

***A. M. A. Kurmut[1], K. Nazari[2] and A. Yahyaoui[2]***

Wheat is the most important grain for the immigrant Nubian people at New Halfa, Sudan. In Sudan wheat rusts are prevalent only in the New Halfa region. Leaf rust and stem rust are important constrains to wheat production. Host plant resistance is the only management strategy used for the control of wheat rusts in Sudan. Trap nurseries received from the international centers (CIMMYT & ICARDA) were sown at New Halfa during seasons 2007/2008, 2008/2009 and 2009/2010 to monitor and evaluate responses to stem rust. The study showed that genes *Sr22, Sr24*, and *Sr36* (Cook) conferred consistent resistance. Lines possessing other genes, such as *Sr25, Sr31*, and S*r36*, showed susceptible reactions, although the lines with *Sr31* and *Sr25* were rust-free in 2009/10.

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## 45. Plan to recover wheat production in Ecuador

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Ecuador had a considerable wheat production tradition until the early 1970s. Local production supplied up to 50% of national requirements. Nevertheless, the area devoted to wheat production dramatically decreased from 100,000 ha in 1969 to 10,000 ha in 2006 (FAOSTAT, 2010). The main causes of the rapid reduction in wheat cultivation were low international prices, low yields and aggressiveness of diseases such yellow rust. Currently, due to lower local production, Ecuador imports 98% of its wheat requirements. In the last few years, instability of the international wheat prices has caused economic and social difficulties in Ecuador since wheat prices have been increasing constantly. This situation has attracted the attention of local authorities, industry, and researchers, who view the situation as a serious threat to food security. INIAP-Ecuador started a Project in 2008 to rebuild wheat production in Ecuador. Three strategic approaches are being followed considered: 1) Development of wheat varieties (with disease resistance, good baking quality and high yield); 2) Training farmers and extension specialists; and 3) Seed production of different seed categories such as 'Registered', 'Certified', and 'Artisanal' by small farmers. As result of the project, three improved wheat varieties have been released. Seed (33,000 kg) of these three new wheat varieties has been delivered to more than 1,000 trained wheat farmers in seven provinces. INIAP efforts will continue with the collaboration of friendly institutions such as Michigan State University and CIMMYT.

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# 46. Adult plant stem rust responses of a doubled haploid wheat population tested under greenhouse conditions

***C. M. Bender[1], Z. A. Pretorius[1] and R. Prins[1,2]***

Phenotyping of stem rust (caused by *Puccinia graminis* f. sp. *tritici*) resistance in adult wheat plants is usually done in the field. The objective of this study was to determine whether resistance can be mapped in adult plants grown and infected in a greenhouse. At the flowering stage, two sets of a Kariega (susceptible) x Avocet S (resistant [*Sr5* and *Sr26*]) doubled haploid (DH) mapping population of 250 lines were inoculated with stem rust races BPGSC and TTKSP, respectively. Stem rust response was recorded 14 days after inoculation as flag leaf infection type, stem severity and stem reaction type. Using composite interval mapping, flag leaf infection types of BPGSC were significantly influenced by regions on chromosomes 6A, 6D and 7D, whereas genes controlling infection types of TTKSP mapped to chromosomes 6A and 7D. Stem severity and reaction type mapped to chromosomes 6A and 6D for BPGSC as opposed to only 6A for TTKSP. The results correspond with the resistance genes postulated to occur in the population. BPGSC is avirulent for *Sr5* and *Sr26* on the Avocet S-derived chromosomes 6D and 6A, respectively, while TTKSP is avirulent only for *Sr26*. The *Lr34/Yr18* gene for leaf rust and stripe rust resistances, derived from Kariega on chromosome 7D, affected the rust response on flag leaves, but not on stems. This study showed that genetic analysis of stem rust resistance in adult plants is possible under controlled conditions in a greenhouse. Further work is necessary to determine whether quantitative trait loci involved in partial stem rust resistance can be mapped using the same experimental approach.

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