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# Proceedings
# Poster Abstracts

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# Poster Abstracts
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# Theme 1: Rust Race Analysis & Surveillance

## 1. Genetic Diversity of Wheat Stem Rust Pathogen *(Puccinia graminis* f. sp. *tritici)* Isolates from Ethiopia as Revealed by Microsatellites

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*Puccinia graminis* f. sp. *tritici* (*Pgt*) causes stem rust, which is a major production constraint of wheat in many warmer countries, including Ethiopia. The pathogen is known to have high genetic and virulence variability throughout the world and has gained evident importance today due to the appearance of race Ug99 that overcomes the widely used resistance gene *Sr31*. Although recent studies indicated high virulence diversity in Ethiopia, the genetic structure of the pathogen is not known in Ethiopia and in most east African countries, where highly virulent races like Ug99 have originated. The present study employed simple sequence repeat (SSRs) markers to determine the genetic structure of *Pgt* isolates sampled in three different regions of Ethiopia. The assays showed high genetic diversity within each population (0.600 - 0.718). On the other hand, the genetic distance between populations was very low (0.08 – 0.315). Cluster analysis placed all isolates, except one, in a single cluster. This, coupled with a low coefficient of genetic differentiation (0.107), indicated an absence of genetic differentiation among populations. The high gene flow among populations (10 per generation) was attributed to the absence of population sub-division. Overall, the pathogen population of Ethiopia is characterized by a high genetic diversity and homogeneity across regions, suggesting that the Ethiopian *Pgt* populations did not evolve independently, and are parts of a larger pathogen genetic pool with a common ancestor. Such phenomena are reminders that the pathogen in Ethiopia can easily adapt to deployed stem rust resistance genes and fungicide treatments. Hence, the agricultural research and development system needs to deploy cultivars possessing "horizontal" resistance to attain durable stem rust control.

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## 2. Wheat Rusts Survey and Virulence of *Puccinia graminis* in Ethiopia

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Wheat (*Triticum* spp) rust surveys were conducted in the main season (June-November) of 2007 and off-season (April-August) of 2008 in the Oromia, Amhara and Southern Nations and Nationalities Peoples regions of Ethiopia. Five hundred sixty two wheat fields in the main season and 76 wheat fields in the off-season were assessed for rust diseases. The mean prevalence of stem rust (*Puccinia graminis*) for the three regions was 30.4%, leaf rust (*P. triticina*) 64.4%, and for yellow (stripe) rust (*P. striiformis*) 47.2% in the main season, whereas the prevalence of stem rust was 14.5% and leaf rust 37% in the off-season. The overall mean stem, leaf and yellow rust incidences in the main season were 16, 40 and 24.9%, whereas the severities were 8.2, 11.2 and 9.9%, respectively. The incidences and severities of the three rusts were low in the off-season. Among the improved bread wheat cultivars sown, Kubsa (with pedigree Atilla), Meda Walabu (TL/3/Fn/TA/Nar59*2/4/Bil'S'), Tuse (Cook/VEE'S'//Dove'S'/Seri), and Galema (4777(2)//FKN/GB/3/PvN'8') were affected by all three rusts. Stem rust samples isolated from these and other cultivars were variable. Of 23 pathotypes identified, 37% were virulent for *Sr31*, 48% were virulent for *Sr36*, and about 4% of isolates were virulent for both *Sr31* and *Sr36*. These virulent stem rust isolates were collected from wheat fields in the southeastern, central, western and northern parts of Ethiopia. Gene *Sr24* was effective against all isolates.

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# 3. *Puccinia striiformis* f. sp. *tritici* Race Changes in the United States

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Stripe rust, caused by *Puccinia striiformis* f. sp. *tritici*, is most frequently destructive on wheat in the western United States and has become more frequently epidemic in the Great Plains and southeastern U.S. states since 2000. Races of the pathogen have been determined every year from infected leaf samples of wheat and grasses, collected throughout the U.S., on seedlings of a set of 20 wheat differential genotypes. From 2000 to 2008, a total of 117 races were detected, of which 79 were first detected during this period. The predominant races, which were first detected in 2000, were the group with basic virulences to Lemhi (*Yr21*), Heines VII (*Yr2*, *YrHVII*), Lee (*Yr7*, *Yr22*, *Yr23*), Fielder (*Yr6*, *Yr20*), Express (*YrExp1*, *YrExp2*), AVS/6*Yr8 (*Yr8*), AVS/6*Yr9 (*Yr9*), Clement (*Yr9*, *YrCle*), and Compair (*Yr8*, *Yr19*). This race group continues to evolve into new races with additional virulences to differential genotypes, including Chinese 166 (*Yr1*), Moro (*Yr10, YrMor*), Paha (*YrPa1*, *YrPa2*, *YrPa3*), Druchamp (*Yr3a*, *YrDru*, *YrDru2*), Produra (*YrPr1*, *YrPr2*), Yamhill (*Yr2*, *Yr4a*, *YrYam*), Tyee (*YrTye*), Tres (*YrTr1*, *YrTr2*), and/or Hyak (*Yr17*, *YrTye*). From 2000 to 2003, the predominant races were PST-78 (virulent on wheat differential genotypes Lemhi, Heines VII, Lee, Fielder, Express, AVS/6*Yr8, AVS/6*Yr9, Clement and Compair) and PST-80 (the same virulences plus virulence on Produra). In 2004 to 2006, the most predominant race throughout the U.S. was PST-100 (the same virulences as PST-80 plus virulences on Yamhill and Stephens). Starting in 2006, races with the virulences of PST-100 or similar races plus virulence to *Yr1* became predominant in California, and PST-114 with combined virulences of PST-100 and virulence to *Yr10* became predominant in the Pacific Northwest. Over the nine-year period, races with more virulences became increasingly predominant, indicating that races with more virulences have advantages over those with fewer virulences.

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# 4. Population Structure of Wheat Disease Pathogens Causing Epiphytotics in Southern Russia

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The north Caucasus region, the main grain crop producing region in Russia, loses annually 450 – 1,050 Kg/hectare of wheat. A major reason for such large losses is the presence of fungal diseases, the most widespread and injurious among them being leaf rust (caused by *Puccinia triticina*), yellow (stripe) rust (*P. striiformis*) and stem rust (*P. graminis*). Leaf rust is detected every year; but the occurrence of yellow rust and stem rust has increased in recent years.

The Laboratory for Cereal Immunity to Fungus Diseases of the All-Russian Institute of Biological Plant Protection has long-term experience in population and immuno-genetic research of the "wheat – rust pathosystem" in developing methodological foundations for development of resistant cultivars and improved crop protection.

The principles of host : parasite systems formulated by Vavilov, Zhukovsky, Flor and others form the basis of the research. One of the research areas is the study of rust virulence.

Wheat field investigations in 2008 indicated average levels of yellow rust development in different agroclimatic zones of the North Caucasus, varying between 1 and 5%. Leaf rust occurred at 1 to 10%, and stem rust was in the range of 1%, mainly in the southern foothills.

Virulence analysis of the wheat yellow rust pathogen population in the North Caucasus region showed that it included isolates virulent to 12 of the 16 differentials being used. Isolates virulent to the lines with genes *Yr5*, *Yr24*, *Yr26*, and *YrSP* were not detected; isolates virulent on lines with *Yr10* and *Yr17* were detected at the rate of 5%; lines with *Yr15*, *Yr27* and *Yr32* at 5-10%; those with *Yr1*, *Yr8* and *Yr9* at 10-25%; on carriers of *Yr6*, *Yr7*, *Yr18* and *YrA*– at more than 25%.

The stem rust pathogen population included isolates virulent to 30 of the 42 carriers of defined resistance genes. Clones virulent to testers with *Sr7a,*

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*9b*, *9e*, *11*, *12*, *21*, *24*, *25*, *29*, *30*, *35*, and *WLD* were not detected; isolates virulent to genes *Sr9a*, *33*, *Sr36* (*Tt1*) and *Dp2* at the rate of 5%; those virulent to *Sr5*, *8a*, *13*, *17*, *23*, *27*, *31*, *32* and *37* at 5 to 10%; those virulent to *Sr9d* (*Sr1*), *6*, *7a*, *8b*, *9g*, *14*, *15*, *20*, *22*, *26*, *36c* at 10 to 25%; and those virulent to *Sr9d* (*Sr1*), *10*, *16*, *19*, *Tt2* (*37*) at more than 25%.

In the leaf rust pathogen population, clones virulent to testers with *Lr9*, *19*, *24*, *29*, *41*, *42*, and *43+24* were not detected. At the same time, high frequencies of clones virulent to lines with *Lr1*, *2c*, *3*, *3ka*, *10*, *11*, *14a*, *14b*, *16*, *17*, *23*, *26*, *28*, *30*, *33*, *40*, and B (more than 40%) were detected. Isolates virulent to testers with *Lr52* (*LrW*) and *Lr45* were present at the rate of 2-3%.

The research results of the rust fungal population structure can be applied in the selection of the wheat cultivars, selection for resistance to specific pathogen races, cultivar recommendation and resistance sources, and recommendations on chemical protection of individual wheat cultivars.

## 5. Variability in Responses to *Puccinia graminis* pers. f. sp. *tritici* on Different Host Plants

***ES Skolotneva, SN Lekomtseva***

Parasitic fungi need to keep up with changing environments that are comprised of the natural environment, specific biochemistry and resistance systems of the host plant. Consequently, the genomes of parasitic fungi evolved to be highly flexible. Stem rust (caused by *P. graminis* f. sp. *tritici* (Pgt)) is a dangerous pathogen that infects wheat and some grasses. This pathogen is distributed worldwide, including Russia. There is wide genetic variability within this *formae specialis*. Pgt was collected from barberry, wheat, barley and wild graminaceous species in various regions of Russia (Central Region, Northern Caucasus, Western Siberia) between 2001 and 2005. A total of 309 monouredinial clones were isolated and multiplied on a susceptible wheat genotype. The Shannon diversity index (Shannon's index) was used to evaluate diversity of race composition of populations depending on the season, host plant and geographical zone. In 2001-2005 race composition of Pgt was very diverse; 43 pathogenic races, 2-3 of which dominated in each year, were identified. The frequencies of other races were less than 8%. We classified these races as rare. The percentages of rare races varied from season to season. The highest diversity of fungal races was observed in the 2001and 2002 seasons which were relatively favorable for the development of wheat stem rust. The race composition on various host plants in Central Russia (Moscow region) revealed that the Pgt clones obtained from barberry were the most diverse. Our results suggested that the sexual process contributed to the diversity of Pgt on wheat in this region, as well as to the variability and race composition of samples collected from wild cereals. Evaluations of the responses of isogenic wheat lines indicated that in 2001-2005 most of them, excluding those with *Sr11*, *Sr9b* and *Sr13*, were resistant.

Using isozyme and randomly amplified polymorphic DNA (RAPD) markers we performed an analysis of Pgt isolates from various grasses and barberry. Pgt isolates clearly segregated into three groups: one from barberry and the others from *Elytrigia* and *Hordeum*. RAPD analysis showed that the genotypes of isolates collected from barberry (Central Russia) clustered into a distinctive stable (bootstrap index up to 94%) group. By contrast, clusters of the MDG pathotypes of the "barberry" isolates were more similar to isolate groups from grasses, probably indicating that the pathotypes occurring on barberry and grasses are different from those occurring on wheat. Analysis of MDH phenotypes revealed a geographic variation among the isolates collected from different grass species. On the other hand, RAPD profile- based groups of Pgt isolates were independent of their geographic origins. The particular host plants determined the structure of RAPD diversity. These results could suggest there are several trends of Pgt variability at the molecular level.

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# 6. Occurrence of Wheat Rusts in Turkey During the 2008 Growing Season

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The rusts are major diseases of wheat in Turkey and they can cause significant yield losses in years with suitable conditions. However, rust prevalence changes from year to year and from region to region depending on climatic conditions. This study was conducted to monitor the occurrence of rusts in different parts of Turkey in 2008. Survey trips were conducted covering the Marmara, Aegean, Thrace, East Mediterranean, Southeast Anatolia, Central Anatolia, East Anatolia and Mid-Blacksea regions. Two hundred and forty two wheat fields were examined for the presence of stripe rust, leaf rust and stem rust. The frequencies of infected plants were recorded and severities were estimated using the Modified Cobb scale. Seventy one fields were infected with rusts. Of these, 60 were infected with stem rust, 6 with leaf rust, and 9 with stripe rust. In some fields, more than one rust was present. In 2008 Turkey suffered from severe drought which was so severe that some fields were not harvested. Stem rust was most prevalent in inner parts of Black Sea region. Severities of rust diseases were therefore non-significant. However, their occurrences under such dry conditions indicate that they keep their potential to cause severe losses.

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# 7. Evolution of the Leaf Rust Pathogen on Durum Wheat in Northwestern Mexico

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CIMMYT-derived durum wheat *(Triticum turgidum* var *durum*) germplasm was highly resistant to leaf rust (caused by *Puccinia triticina*) to prevalent race BBB/BN in Mexico until 2000. However, a large portion of the germplasm was susceptible in Chile and North Africa. A new race, detected in northwestern Mexico in 2001, was virulent on more than 80% of the germplasm, including the most popular cultivar Altar C84. This race was designated BBG/BN. Apparently a single gene mutation towards virulence on *Lr11* was observed, but virulence to the undesignated gene in Altar indicated the possibility of an exotic origin. During the same year a variant, designated as BCG/BN, was identified with an unnecessary virulence for resistance gene *Lr26* present in the 1B.1R translocation in bread wheat (*T. aestivum*). In 2008 leaf rust was observed on previously resistant durum cultivars Jupare C2001 and Banamichi C2004. Single pustule isolates indicated the presence of a new race designated BBG/BP, which evolved through a single mutation in race BBG/BN for virulence to the complementary resistance genes *Lr27*+*Lr31* present in Gatcher, Jupare C2001 and Banamichi C2004, and adult plant resistance gene *Lr12*. A variant isolate of race BBG/BP, designated as CBG/BP, with additional virulence for *Lr3* present in CIMMYT durum 'Storlom' was also identified. Although virulence to *Lr3*, *Lr12* and *Lr27*+*Lr31* is known to occur in *P. triticina* races predominant on bread wheat, this is first time that we identified such virulences in races predominant on durum wheat. Since the introduction of BBG/BN in Mexico in 2001, this durum *P. triticina* race has continued to evolve and defeat race-specific resistance genes commonly present in both durum and bread wheat.

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# 8. Wheat Rusts in India - Pathogenic Changes

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Surveys and surveillance of wheat rusts began in India in 1930 and the rust pathotyping was done at the Wheat Rust Laboratory, Shimla. Since then pathogenicity surveys have detected many changes in the rust pathogens. The changes can generally be divided into two periods, viz. the pre-Mexican influence period (referred to as first period) and the post Mexican influence period (second period). *Puccinia graminis tritici* from the first period was virulent on plants wirh *Sr9d* and *Sr9g* and local durums and cultivated emmers, except Khapli, were susceptible. However, Khapli was resistant. The second period witnessed acquisitions of virulences for *Sr5*, *8a*, *9b*, *11*, *13* and *14* (Khapli), *24*, *25*, and *28*. Most of the changes were for *Sr5*, *9b*,*11*, and *13* whereas there were a few for *Sr24* and *Sr25*. Some of these changes could be attributed to the introduction of cultivars carrying corresponding resistance genes (like Kalyansona and Sonalika), whereas others were not related to host genotypes. Leaf rust in the first period was avirulent for most of the named genes. The second period witnessed changes for many genes including *Lr1*, *2a*, *3*, *10*, *13*, *20* and *26*. The most common changes were observed for *Lr23*, *26* and *13* and more recent changes to virulence for *Lr9*, *19* and *28* were not related to the introduction of varieties with the corresponding resistance genes. For stripe rust, the pathogen was virulent for *Yr6* and *7* in the first period, and in the second period, the pathogen acquired virulences for many genes including *Yr2, A, 4b, 9, 25* and 27. Some of these changes were related to the introduction of varieties such as Kalyansona (*Yr2*), Sonalika (*YrA*), Veery#5 (*Yr9*), and PBW343 (*Yr9+27*), but other changes such as those corresponding to *Yr4b* and *Yr25* could not be related to host genotypes.

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# 9. Effective Rust Resistance Genes in Wheat under Moroccan Conditions

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In order to evaluate the effectiveness of leaf rust and yellow (stripe) rust resistance genes, a set of leaf rust and a set of yellow rust differentials were grown under field conditions and tested for rust resistance in three contrasting locations (Meknès, Douyet and Annoceur). The sowing date was around the end of November in plots of two 0.5 m rows 30 cm apart. The rust diseases were scored during grain filling according to the modified Cobb scale coupled with reaction types to calculate coefficients of infection (CI). During the 2006-07 season, yellow rust was the most prevalent disease at all three sites. Leaf rust was observed only at Meknès. Since yellow rust precedes leaf rust in time of appearance, the latter could not be scored on lines that were highly susceptible to the former. The coefficients of infection for yellow rust ranged from 0 to 50, 0 to 80, and 0 to 90 at Annoceur, Douyet and Meknès, respectively. Lines possessing *Yr1, Yr5, Yr10, Yr15, Yr17, YrSP*, and to some extent, *Yr8*, were highly resistant at the three sites, whereas lines with*Yr18* and *Yr27* exhibited some interaction with sites. They were highly effective at Meknès, moderately so at Annoceur, and less effective at Douyet. Lines carrying *Yr9, Yr7, Yr6* and *YrA* were susceptible at all three sites. At Meknès, the coefficient of infection for leaf rust ranged from 0 to 80. The line carrying *Lr23*+ exhibited immunity and that carrying *Lr20* exhibited only traces of pustules. The lines carrying *Lr21, 29* and *34* exhibited co-efficients of infection (CIs) of 5. Lines carrying separately *Lr10, 12, 13, 14a, 14b, 15* and *28* exhibited CIs of no more than 10. In contrast, lines carrying the slow rusting character were completely immune towards leaf rust. These lines were also free of yellow rust. Moreover, many combinations of *Lr* genes, such as the combination *Lr10, Lr27+Lr31, Lr34*, gave very good levels of leaf rust resistance. It is of interest to mention that the lines carrying *Yr1, Yr5, Yr10, Yr15, Yr17* or *YrSP*, that were highly resistant to yellow rust, were also resistant to leaf rust, as well as having high agronomic scores.

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# 10. Survey of Wheat Diseases in Morocco During the 2007-08 Growing Season

*A Ramdani*

There are many biotic constraints to wheat production in Morocco. Leaf rust, septoria leaf blotch, and to some extent, yellow (stripe) rust are the most damaging diseases on wheat. The objective of this survey was to assess the prevalence, incidence and severity of wheat diseases across Morocco in order to produce a multi-layered map. Such a map is a very useful tool to tailor breeding objectives and for more objective deployment of the available commercial cultivars. This survey, which is planned to be ongoing, is also the backbone of pre-breeding activities dealing with disease resistance. The survey also permits collection of pathogen samples for determination of genetic diversity and virulence phenotyping. The survey was carried out during the first half of April, 2008, in the Chaouia, Abda, Doukkala and Saïs areas when the growth stages of the wheat crop ranged from milk to physiological maturity. In the area of Middle Atlas, the survey was carried out during the second fortnight of June, 2008, also corresponding to the milk to physiologically mature stages. The data recorded were host species, growth stage, visual assessment of grain yield, and incidences and severities of the main diseases from which the prevalences were computed.

In order to avoid a biased assessment of the importance of necrotrophic foliar diseases separately, namely Septoria leaf blotch, Septoria glume blotch and tan spot (yellow spot), because of the similarity of symptoms and the scarcity of fruiting bodies (pycnidia), we assessed the complex, hereafter named Septoria-like-diseases (SLD). A total of 96 fields were inspected, the numbers for each being 43, 22, 30 and 1 fields for bread wheat, durum, barley and triticale, respectively.

This survey revealed that the most prevalent diseases on both bread and durum wheats were Septoria-like diseases, leaf rust and, to some extent, yellow rust and stem rust. Powdery mildew and common bunt were less prevalent and were detected only on bread wheat. Overall, 63% and 59% of bread wheat and durum wheat fields, respectively, were infected by SLD, while leaf rust was detected in 79% and 64% of fields, respectively. Stem rust was detected on 16% and 9% of bread wheat and durum fields, respectively; and yellow rust was detected on 9% of fields for both species. The survey provided information on the potential threat of the various diseases, although their severities in 2008 were not high because of the unfavorable environmental conditions.

INRA Morocco, Ville Nouvelle, BP Meknès, Morocco

# 11. Diverse Stem Rust Races Found in a Single Field in Washington, USA

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In 2007, a spring barley field in northeastern Washington State was severely infected by stem rust and a bulk sample was collected. Preliminary testing on wheat stem rust differentials suggested that the sample consisted of many different virulence types. To further characterize the virulence types, we derived 83 single-pustule isolates: 63 isolates from Line E wheat, 15 from Hiproly barley, and 5 from Prolific rye from inoculation with urediniospores collected from the sample. All isolates were race-typed in two replicates on the 20 North American stem rust differential lines and eight supplemental wheat lines, viz. Line E, Chinese Spring, LMPG-6, Little Club, Rusty, Morocco, Federation, and Gabo, most of which are considered to be widely susceptible to *Puccinia graminis tritici*. Twenty seven races were identified from the 83 isolates. The most frequently identified races included BBBBB, JCBBB, and QHMJC. The supplemental lines further differentiated the isolates because isolates within each of the races frequently displayed different reactions on the supplemental lines. It is likely that this population consisted of several *formae speciales* in addition to *P. graminis* f. sp. *tritici*. The isolates were genotyped with 20 SSR markers. Our results demonstrated the vast diversity of stem rust races present at this location. This population is likely derived from the sexual cycle of *P. graminis*. Barberry is widely distributed in the region.

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# 12. Status of Wheat Rusts in Uzbekistan

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Rusts are the most important biotic stresses to successful wheat cultivation in Uzbekistan. Leaf (*P. recondita*) and yellow (*Puccinia triticina*) rusts occur every year and cause substantial wheat grain yield reductions in Uzbekistan. Stem rust (*P. graminis tritici*) is found only in foothills and flat-hilly zones towards wheat crop maturity causing only limited yield reductions in the past. However, the analysis of wind stream directions and registered migration of the races of yellow rust, such as the virulent race to gene *Yr9*, has confirmed that East Africa and whole Asia, except for China, enters into one epiphytotic zone. It makes highly probable the migration of Ug99 by air up to Central Asia including Uzbekistan. At the same time, FAO and other international agricultural centers call for vigilance, warning about serious dangers of penetration of race Ug99 of stem rust and its changed variants to Central

Asian countries including Uzbekistan. Monitoring the races of yellow and leaf rusts and screening for resistance are done on a regular basis in Uzbekistan through international collaborations using disease trap nurseries. Rust resistant genotypes are used in crossing program to improve rust resistance of the local wheat varieties. The Uzbek wheat germplasms were also tested for resistance to race Ug99 of stem rust in Kenya in 2008. Only 8 of the 67 accessions of bread and durum wheat from Uzbekistan were found moderately resistant (10-40 MR) to Ug99 in the field test in Kenya. Among eight resistant genotypes, a resistant winter wheat variety 'Kroshka' from Russia is widely cultivated in Uzbekistan under irrigated conditions. Another resistant variety 'Sanzar-6' is cultivated under rainfed conditions. Three new varieties 'Tamara', 'Turakugan' and 'Emir' also showed good levels of resistance (10 and 30 MR) to Ug99 in two evaluations (2007 and 2008) in Kenya. Since the above resistant varieties possess high productivity and superior bread making qualities, they could be used for developing Ug99 resistant improved wheat varieties in Uzbekistan. Data from the ongoing and past rust screening nurseries in Uzbekistan will be discussed.

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