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Monitoring of Variability in Wheat Rust Pathogens by International Trap Nurseries

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ABSTRACT: Protection of wheat from rust diseases caused by *Puccinia* spp. has very special significance for Georgia. The resistance to wheat stem, leaf and yellow rusts of 415 wheat cultivars and advanced breeding lines, consisted in 7st IYRTN and 8thIYRTN, 8th ISRTN and 9th ISRTN, and 5th ILRTN as well, were studied under natural infection in 2013-2014 years in different geographic zones of Georgia and important resistance sources including the cultivars with different Sr, Yr and Lr- resistance genes have been revealed.

Key Words: Wheat, Yellow rust, Resistance, Trap nurseries, Severity.

INTRODUCTION

Wheat rusts have caused massive yield losses of wheat wherever it occurred. The three factors in the disease triangle are all essential for rust's development. However, their development depends even more on the very specific weather conditions when pathogen inoculum and susceptible host plants are present. The three most important weather factors affecting epidemics of rusts are moisture, temperature, and wind. The climate change creates difficulties and significantly affects the behavior and interaction of host-plant and pathogen. Example of this is a well-known group of Ug99 races, have been established in East Africa and Yemen and have spread to the Islamic East Africa and Yemen and Republic of Iran and South Africa; or the breaking of resistance to yellow rust, conferring by Yr27, that has caused severe outbreaks and losses in many countries in North and East Africa, the Near East and South Asia (FAO, 2014). In recent years wheat rust diseases have been effectively controlled through breeding for rust resistance genes. The breeding of new varieties and their implementation is economically and ecologically reasonable method for control rust diseases. However breeding of high and sustained resistant varieties is a quite complex task, which depends on knowledge of about pathogen's virulence structure and wide-scale search for resistance sources for breeding uses. It is essential to have not only different varieties, but ones with different sources of resistance as well, which makes it more challenging.

Wheat rust populations can be highly diverse for virulence phenotypes. Changes in pathogen virulence have rendered some resistances ineffective, resistant cultivars have generally been developed ahead of significant damage. Knowledge on virulence variation in the natural pathogen population helps breeders in proposing efficient resistance strategy to rusts.

Rusts trap nurseries are targeted for wheat growing areas and are planted at locations where rusts is known to occur naturally each year. Trap Nursery consists of isolines with resistance genes, genetic stocks for additional Yr, Sr and Lr genes, selected differentials, wheat varieties carrying combinations of important resistance genes, and important commercial varieties currently grown in different regions and it is designed to collect information on epidemiology and physiologic specialization of rusts, behavior of resistant and susceptible varieties, tested under different environmental conditions.

Protection of wheat from rust diseases caused by *Puccinia* spp. has very special significance for Georgia. This is because it is one of the centres of evolution of wheat and its pathogens, where their evolution preceded the presence of intermediate plant-hosts. The reservoirs of infection in wild cereals and optimum climatic conditions all contribute to the regular development of wheat rust and consequently severe crop losses in the region. So, the nurseries are very important for Georgia, where all four rusts are presented essentially everywhere where cereals are grown.

MATERIALS AND METHODS

Plant materials. The resistance to wheat stem, leaf and yellow rusts of 415 wheat cultivars and advanced breeding lines, consisted in 7st IYRTN and 8thIYRTN, 8th ISRTN and 9th ISRTN, and 5th ILRTN as well, were studied under natural infection in 2013-2014 years in different geographic zones of Georgia. The assessments in the diseases nurseries were planted in middle autumn in two rows with 1 meter length spaced 20 cm apart, at a rate 120 seeds per meter; between every 10 rows the check variety - Morocco was planted.

Field test and diseases scoring. Scoring of rust diseases is carried out on flag leaf or the whole plant. Often, Leaf and Stripe rusts are scored on a single observation using a flag leaf. Stem rust is scored on the stem leaf sheath and true stem.

We evaluate of adult plant resistance in the field on the basis of host response to infection (pustule type and size (Roelfs *et al.*, 1992), four times, at a 7-8-day interval, and disease severity - the proportion of the possible tissue surface (%) area infected by rust, following to the modified Cobb's scale (Peterson *et al.*, 1948). The host response scored in the field are: "R"- resistance or minimum uredinia; "MR" – moderately resistance, small uredinia; "MS" – moderately susceptible, moderate size uredinia; "S" – Full susceptibility. Disease severity levels <20% were classified as low; Moderate levels ranged from 20% to 40%. Infection levels with incidence and severity >40% were classified as high (Hodson et al., 2009).

RESULTS AND DISCUSSIONS

7st IYRTN and 8thIYRTN, 8th ISRTN and 9th ISRTN, and 5th ILRTN were planted during the 2013-2014 cropping seasons in different geographic zones of Georgia. The resistance of two sets of International Yellow Rust Trap Nurseries -7st IYRTN and 8thIYRTN were evaluated within different geographic zones of Georgia: Shida Kartli (Borjomi region), and Kolkheti lowland, Kobuleti, on the Phytopathology and Biodiversity Institute lands. A climate in Borjomi is continental, with moderate, cold winter, hot long summer, and climate of Kobuleti is typical for humid subtropics of Western Georgia, with warm winter and hot summer.

2013 crop season was marked by dry conditions in Georgia and yellow rust developed very weakly than in 2014. However, in 2013 moderate level of disease incidence (30-40%) was indicated on Morocco. Low infection was recorded on susceptible entries. 66% and 79% of tested entries showed moderate resistance (MR) in 2013 and 2014, respectively. Data of trap nurseries over two years indicated that several known resistance genes Yr6, Yr7, Yr8, Yr18 have limited utility as host lines carrying them displayed susceptibility in both years. The varieties Ciano 79(Yr27), Attila (Yr27+), Opata 85(Yr27+Yr18), Lal Bahadur/ Pavon (Yr29) and Lemhi (Yr21) with severities from 30MS to 70MS had ineffective adult plant resistance. Lines with genes Yr1, Yr2, Yr5, Yr 10, Yr15 and Yr25 showed high resistance at most sites. Resistance reaction of accessions with Yr10 and Yr15 (Yr 10/ 6* Avocet S; Yr 15/ 6* Avocet S) we have observed for a long time in all stages of wheat development, while original Avocet 'S' have been infected with high severity. These genes are main resistance genes widely deployed in breeding programs. Based on our evaluations genes *Yr1, Yr5, Yr17, Yr25,* as well as Spaldings Prolific (YrSP), Nord Desprez (YrND), Carstens V (Yr32), Anza and Jupateco 'R' are still effective and also could be used in breeding programs. Cultivar Pastor that carries Yr31 in combination with APR gene remains highly effective in all locations many years.

Nearly all commercial varieties were resistant and moderately resistant in 2013 and 2014 in all sites, but in 2010 the cultivars Cham 8, Sardari, Alamaut and Bohouth 6 showed moderate susceptibility (40MS).

Two sets of Stem Rust Trap Nurseries (8th ISRTN, 9th ISRTN) included 85 entries were also assessed under natural infection in two sites (Kobuleti, Borjomi) during 2013-2014 growing seasons. In 2013 wheat stem rust was severe than in 2014. Its severity varied between 10MS-60MS and 1MS-10MS in 2013 and 2014, respectively. In Kobuleti 73% of entries were found highly resistant to stem rust with "0" or trace level of infection. No significant difference was found in results from Borjomi region (Eastern Georgia), where stem rust severity was higher than in Kobuleti. About 70% and 10% of lines showed resistance and moderate resistance to stem rust respectively. Virulence to lines with genes Sr 7a, Sr 7b, Sr8a, Sr 9a, Sr 9b, Sr9d, Sr21, Sr24, Sr25, Sr26, Sr27,Sr28,Sr29, Sr31, Sr32, Sr33, Sr34, Sr36, Sr37 have not been detected.

The existence and severity of leaf rust natural infection were assessed in 2014 on the 85 entries of 5th ILRTN-14 in Kobuleti. Resistance of 60 % of entries was indicated. 34,1% among them showed R type. Good resistance to leaf rust have been expressed on lines with genes Lr2b, Lr9, Lr18, Lr19, Lr21, Lr 10+ 27+31, Lr28, Lr29, Lr37. It should be mentioned that these genes have remained effective to leaf rust pathogen for a long time in Georgia.

Table 1: Effective Sr, Lr and Yr-resistance genes in Georgia in 2013-2014 according to results of testing International Trap Nurseries.

#	Disease	Effective resistance genes
1.	Stem rust	Sr 7a, Sr 7b, Sr8a, Sr 9a, Sr 9b, Sr9d, Sr21, Sr24, Sr25, Sr26, Sr27,Sr28,Sr29, Sr31, Sr32, Sr33, Sr34, Sr36, Sr37
2.	Leaf rust	Lr2b, Lr9, Lr18, Lr19, Lr21, Lr 10+ 27+31, Lr28, Lr29, Lr37.
3.	Stripe rust	Yr1, Yr2, Yr5, Yr 10, Yr15, Yr25, Yr31

Thus, our results showed that a majority of tested accessions (about 66%) had high and moderate resistance to Georgian population of stripe, stem and leaf rusts; Important resistance sources including the cultivars with different Sr, Yr and Lr- resistance genes have been revealed for Georgia based on nursery testing data. These research results could be useful for the national and international breeding programs.

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