Research Article
www.ekinjournal.com
Ekin
Journal of Crop Breeding and Genetics
(2015) 1-1:63-68

Reaction of wheat germplasm to stem rust in Georgia

Zoia Sikharulidze [1] Lali Mgeladze [1] Rusudan Dumbadze[1] Ketino Natsarishvili [1] Nana Chkhutiashvili[2]

[1] Batumi Shota Rustaveli State University, Institute of Phytopathology and Biodiversity Kobuleti, Georgia, 90, str. Tavisupleba, Kobuleti, 6200, Adjara, Georgia

[2] Agricultural University of Georgia, Lomouri Institute of Farming, Tbilisi, Georgia, 13km, David Aghmashenebeli Valley, Tbilisi 0159, Georgia

Corresponding author e-mail: **zsikharulidze@ymail.com**

Citation:
Sikharulidze Z, Mgeladze L, Rusudan Dumbadze R, Natsarishvili K and Chkhutiashvili N 2015. Reaction of wheat germplasm to stem rust in Georgia. Ekin J Crop Breed and Gen 1-1:63-68.

Received: 23.02.2014 ***Accepted: 19.07.2014*** ***Published Online: 15.01.2015*** ***Printed: 25.01.2015***

ABSTRACT

Stem rust had represented a major threat to wheat production in the world including Georgia. Breeding for resistance to rusts is a major strategy for most wheat improvement programs. The wild and domestic relatives of wheat are important sources for disease resistance. Therefore, the objective of this study was identification of resistant genotypes to Georgian races of stem rust.

A collection of fifty wheat accessions including endemic wheat species and subspecies, domestic varieties, new advanced cultivars and introduced entries from different international nurseries were evaluated under the artificial infection of stem rust in the field and greenhouse conditions. The wheat germplasm was screened using the predominant stem rust races mixture of Georgia. Resistance was detected in majority of the tested entries. The endemic species: *Triticum monoccoccum* (var.*laetissimum* Korn), *Triticum timopheevi* (var.*tipicum* Zhuk -var.*viticulosum* Zhuk), *Triticum georgicum* (var.*chvamlicum* Supat), *Triticum dicoccum* (var. *farrum*), *Triticum carthlicum* Men (var. *fuliginosum* Zhuk), *Triticum carthlicum* Men (Var. *stramineum* Zhuk), *Triticum macha* Dek et Men (var. *megrelicum*), *Triticum macha* Dek et Men (var. *colchicum*), *Triticum macha* Dek et Men (var. *palaeo-imereticum*), *Triticum spelta* (var.*dekaprelevichi Dorof*) and old Georgian varieties: Khulugo, Tetri ipkli were resistant and moderate resistant to stem rust. Also, some introduced accessions (DBDI-2WWSRRN-34, Dorade/altay2000/4Bez/Nad//LZM (es85.24)
3/F900k, Haurani / aegtaushi / cham6-6 / mz / cno67 / 3Ifn / 4 / ant / 5 / Attila-19FAWWON, Sunco / pastor-19FAWWON, SRMA / tui / / babax / 3JGR-11LR-Res-132, BTZ-18FAWWON-IRR-149) showed moderate resistance.

***Keywords*:** wheat, landraces, species, resistance, rust

Introduction

Georgia is a country of origin of wheat and presents an ancient center of agriculture. At the same time it is distinguished by a diversity of a number of unique endemic species and old local varieties of different crops. Therefore, the genetic resources spread in Georgia are significant not only from historic point of view, but also for selection of the valuable varieties for cultivation.

The wheat is very old crop for Georgia; it is presented with very large diversity which is stipulated by variation of soil and climate condition of Georgia. There has been described 14 species of wheat out of which 5 are endemic and there are numerous Georgian landraces of wheat. The local wheat has many unique features such as high immunity, and high biochemical and technological quality of grain. They also were adapted well to the local conditions (Menabde, 1948). The bread and other products made from this wheat were highly appreciated among local population and they were deeply connected with national traditions and custom. However, local varieties have been disappearing from agriculture. The new commercial varieties replaced land races. Most of these varieties are susceptible to the local races of major diseases and produce low yield. The low yield of wheat in region can be explained by stable development of diseases, low-yielding and poorly-adapted varieties etc. Breeding for disease resistance remains the major way for control of diseases.

Rusts are recognized as a widely occurring and most damaging disease of wheat in the world. Wheat stem rust is a most feared disease due to its ability to inflict substantial losses. The last major stem rust epidemics occurred in various countries (Kenya, Ethiopia, Uganda, Yemen) caused grain losses of up to 70% in farmer's fields (Wanuera, 2008; Pretorius et al, 2000; Bariana, 2008). FAO estimates that 30 countries are either affected by Ug99 or at potential risk. There is a chance that Ug99 will reach Georgia where barberry is widespread (Anonymous, 2008). However, stem rust incidence and severity recorded during 2011-2013 cereal rust surveillance surveys were mainly moderate and low, respectively (Sikharulidze et al, 2013).

Because a large proportion of the world's commercial wheat varieties are susceptible to Ug99, new sources of rust resistance are required for breeding improved varieties. Growing of resistant varieties is well-known to be the cheapest and ecologically safe method of the crop protection. Creation of such varieties requires constant search of the trait donors i.e. new sources with high level of resistance expression. The wild and domestic relatives of common wheat are important sources for resistance to diseases. In addition, as rust pathogens are highly specialized and evolution of new virulence is more frequent in pathogen population, breeding for resistance to this disease should always be more systematic and dynamic.

The objective of this study was to evaluate the stem rust responses of a range of wild relatives, local varieties and introduced germplasm from international nurseries.

Materials and methods

A collection of fifty wheat accessions including twelve endemic wheat species and subspecies, nine domestic varieties, seven advanced varieties and nineteen introduced entries from different international nurseries were evaluated under the artificial infection of stem rust both in the field and in the greenhouse conditions. Experimental material has been received from Lomouri Farming Institute of Georgia. The wheat germplasm was evaluated for reaction to mixture of four predominant stem rust races (PHCQF, CFHC, PHCMF,NHPGF) in Georgia. These races contained the virulence on Sr 5, Sr 6, Sr 7b, Sr 9e, Sr 9a, Sr 9g, Sr9d, Sr 17, Sr 30, Sr 38, Sr McNair and SrTmP. The races structure of the stem rust population was determined according to the identification system (Roelfs and Martens, 1988) based on inoculation of isogenic Sr-lines with *Puccinia graminis* spores. The spores of prevalent stem rust races identified from Georgia regions were multiplied on cultivar Morocco and collected in separate test tubes to inoculate wheat cultivars.

Seedlings consisted of eight to ten plants per wheat entries were tested under the greenhouse conditions. Seven-day-old seedlings were inoculated in the second leaf stage with the water-spores mixture (approximately 3-5mg of freshly collected spores per 1ml of distilled water suspension) and incubated during 24 hours in a dew chamber in dark condition at 20-220C and 100% humidity. After that plant were transferred to a glasshouse where the temperature varied between 22-250C and relative humidity 60-70%. For each seedling, infection types (IT) were recorded 12-14 days after inoculation, based on a 0-4 scale of Stakman et al, (1962). ITs "0" to 3- were regarded as low IT and ITs "3" and "4" as a high IT.

Field trails were established on autumn (25 October) 2012. Each entry was sown in three 1-m long rows spaced 15 cm apart. Cultivar Bezostaya 1 was used as susceptible check. In early May, 2013 the plants were inoculated at the flag leaf stage with the mixture of same races of stem rust by spraying the spore-water suspension. Inoculated plants were covered by polyethylene film for a moist chamber. Data of infection types were recorded 12-14 days after inoculation according to the host response (Roelfs et al, 1992). Two types of scoring were combined: a) the host response to infection in the field was scored using 'R' to indicate resistance or miniature uredinia; 'MR' to indicate moderate resistance, expressed as small uredinia; "MS' to indicate moderate susceptible, expressed as moderate size uredinia somewhat smaller than the fully compatible type, and "S' to indicate full susceptibility. b) The modified Cobb's scale (Peterson et al, 1948) was used to determine the percentage of possible tissue (100%) rusted. The disease scorings were performed with the appearing of the first symptoms with ten day intervals three times.

Results

The responses of fifty wheat accessions including wheat species, domestic landraces and introduced entries from different international nurseries to stem rust races at seedlings and adult plant stages are presented in Tables 1 and 2. High and moderate level (R, MR) of juvenile and adult resistance to the disease was detected in nearly all tested species: *Triticum monoccoccum* (var.*laetissimum* Korn), *Triticum timopheevi* (var. *tipicum* Zhuk-var.*viticulosum* Zhuk), *Triticum georgicum* (var.*chvamlicum* Supat), *Triticum dicoccum* (var.*farrum*), *Triticum carthlicum* Men (var. *fuliginosum* Zhuk), *Triticum carthlicum* Men (var. *stramineum* Zhuk), *Triticum macha* Dek et Men (var. *megrelicum* Men), *Triticum macha* Dek et Men (var. *colchicum*), *Triticum macha* Dek et Men (var. *palaeo-imereticum*) and *Triticum spelta* (var. *dekaprelevichi Dorof.*) Exception was *Triticum durum* Desf. and *Triticum compactum* Host (var. *icterinum*) which showed the susceptibility at seedling stage. Only two old domestic varieties (Khulugo and Tetri ipkli) out of nine under study were moderate resistant to stem rust in both stages. cv. Vardzia showed MR reaction in seedling stage but it was susceptible in adult stage.

Effective adult resistance was found in seven varieties: Sauli 9, Lomtagora 123, Lomtagora 126, Lomtagora 109, Lomtagora 107, Lomtagora 149, Lomtagora 155, which were selected from international nurseries developed by ICARDA and CIMMYT during years and accepted for release in Georgia. These introduced entries were highly or moderately resistant at seedling stage too. Turkish variety Somnez was moderate resistant in seedling stage but in adult stage it showed susceptibility.

A consistent resistant reaction both in the seedling and adult plant stages was confirmed in six introduced accessions out of twenty: Haurani/aegtaushi/cham6-6/mz/cno67/3Ifn/4/ant/5/Attila-19FAWWON, Dorade/altay2000/4Bez/Nad//LZM-3/F900k-alres5, SRMA/tui//babax/3JGR-11LR-Res-132, DBDI-2WWSRRN-17, Sunco/pastor-19FAWWON, BTZ-18FAWWON-IRR-149. All tested entries were resistant in seedling stage but twelve introduced entries showed susceptible reaction in the field.

Discussion

The Georgian wheat landraces have been widely used in breeding of wheat as they represent rich sources of genes conferring resistance to diseases. Over the years, breeding for rust resistance has been based on Georgian endemic wheat species: *Triticum timopheevi, Triticum zhukovski, Triticum carthlicum* in the world. Much experience has been gained using wild wheat relatives for identification of new resistance sources (Tyryshkin et al, 2011; Knott and Zang, 1990; McIntosh and Gyarfas, 1971; Dekaprelevich, 1961) For instance, *T. timopheevi* and *T. monococcum* are known as valuable sources of resistance to the main fungal diseases, which have been incorporated into some improved varieties (Tomerlin et al, 1984, Brown-Guedira et al, 1996; Beteselassie et al. 2006). *Triticum carthlicum* was found to have also resistance to leaf and stripe rusts (Dekaprelevitch and Naskidashvili, 1976).

The results of our research showed that a majority of tested accessions had high and moderate resistance to Georgian population of stem rust where effective resistance genes were the followings: Sr11, Sr21, Sr24, Sr36, SrTmp and Sr31. The results of this study also support this fact that the wild relatives could be valuable sources of resistance to the stem rust races in the area to this day. This research results could be useful for the national and inter breeding programs in either further evaluation the stem rust resistant lines for varietal identification or using them as parents in the crossing. The many Georgian varieties (Vardzia, Bagrationi, Deda, Mukhrani, Motsinave) were developed from local landraces: Dika, Khulugo, Dolis puri (Naskidashvili et al, 1983; Naskidashvili et al, 1993).

Over last 15 years new wheat cultivars were introduced into the country via different ways including genotypes developed by international breeding programs. In this case, it is necessary to evaluate them to the existing stem rust races. To improve productivity of winter wheat in the development countries, the ICARDA and CIMMYT in collaboration with national partners have been working in framework of International Winter Wheat Improvement Program. In accordance with the results obtained from present study seven already released new varieties selected from international nurseries showed high and moderate level of resistance to prevalent Georgian races of stem rust. Also, eight advanced lines with adult resistant were identified.

As resistance genes Sr11, Sr21, Sr24, Sr36, SrTmp and Sr31 are mainly effective in Georgian population of stem rust, it is possible that these genes could be components of stem rust resistance in the tested entries.

Thus, presented research allowed the identification of stem rust resistant germplasm of wheat. These effective rust resistance sources could be widely used for breeding programs for producing new resistant cultivars all over the world.

Table 1. Infection types and field responses of wheat species and old Georgian varieties to stem rust

#	Accessions	Origin/Coutry/	Seedling Infection Types	Adult plant Reaction Types
1	*Tr.monococcum* L. var. *laetissimum* Korn	GEO	1	R
2	*Tr. timopfeevii* Zhuk. var. *tipicum* Zhuk	GEO	1.2	R
3	*Tr. georgicum* Dekap. var. *chvamlicum* Supat.	GEO	2	R
4	*Tr. Dicoccum* var. *farrum*	GEO	1,2	R
5	*Tr.ibericum* Men. var. *fuliginosum* Zhuk.	GEO	2+	R
6	*Tr.ibericum* Men. var. *stramineum* zhuk.	GEO	0-1	MR
7	*Tr.macha* Dek et Men. var. *colchicum*	GEO	2+	MR
8	*Tr.macha* Dek et Men. var. *megrelicum* Men	GEO	2;	MR
9	*Tr.macha* Dek et Men. var. *palaeo-imereticum*	GEO	2	MR20
10	*Tr. spelta* L. var. dekaprelevichii Dorof	GEO	2	MR
11	*Tr.compactum* Host var. *icterinum* Al.	GEO	3	MS
12	*Tr.durum* Desf. (Tavtukhi)	GEO	2+	MS
13	Tbilisuri 5	*T.aestivum* var. *aestivum*	3	80MS
14	Dolis puri 35-4	*T.aestivum* var. *aestivum*	3	80MS
15	Khulugo	*Tr. aestivum* var. *lutescens*	1/2	R-MR
16	Lagodekhis grzeltavtava	*Tr. aestivum* var. *lutescens*	3	MS-MR30
17	Korboulis dolis puri	*T.aestivum* var. *aestivum*	3	80MS
18	Akhaltsikis tsiteli doli	*T.aestivum* var. *ferrugineum*	3	80MS
19	Tetri ipkli	*Triticum aestivum* L.	2+	60MR
20	Vardzia	*T.aestivum* var. *Ferrugineum*	2	50MR
21	Almasi	*T.aestivum* var. *aestivum*	3	80MS
22	Bezostaya 1(susceptible check)		3	90MS

Table 2. Infection types ad field responses of introduced accessions of wheat to stem rust

#	Accessions	Origin	Seedling Infection Types	Adult plant Reaction Types
1	Sauli 9 (*Tr. aestivum*)		2	60MR
2	Lomtagora 123 (*Tr. aestivum*)		1.2	20MR
3	Lomtagora 109 (*Tr. aestivum*)		2	40MR
4	Lomtagora 149 (*Tr. aestivum*)		1,2	20MR
5	Lomtagora 126 (*Tr. aestivum* var. *lutescens*)	Pehlivan/Jagger	2+	20MR
6	Lomtagora 155 (*Tr. aestivum*)	*BEZ/SDV1/5/338-K1-1// TJB368.251*	0-1	30MR
7	Lomtagora 107(*Tr. aestivum*)	CUPRA-1/3/CROC1/AE SQUARROSA	2+	50MR
8	Somnez (*Tr.aestivum* var. *lutescence*)	Turkey	3	80MS
9	Lukillus- *Tr. aestivum*	18FAWWON-IRR-53	2; 2+	50MR
10	BTZ- *Tr. aestivum* var. *lutescens*1	8FAWWON-IRR-149	1,2	5MR
11	Unknown pedigree-2- *Tr. aestivum*	18FAWWON-SA-49	2	60MR
12	Stetatus- *Tr. aestivum*	2WWSRRN – 17	2+	40MS
13	DBDI- *Tr. aestivum*	2wWWSRRN-34	2+	5MR
14	Attila*2/pastor//Orkinos-2-11lr-res-3	11LR-RES-3	2+	70MS
15	Dorade/altay2000/4/Bez/Nad// LZM(es85.24)3/ F900k –aalr-res-5	11LR-RES-5	2	10MR
16	Haurani/aeg taushi/cham6/6/mz/ / cno67/3/lfn/4/ant/5/Attila-	19FAWWON	1/2	20MR
17	Sunco/pastor-	19FAWWON	0	40MR
18	Kupava/burbot-6//Jagger-	11LR-RES-18	2,2+	80MS
19	Demir-	11lr-RES-125	2+	60MS
20	SRMA/tui//babax/3JGR-	11LR-Res-132	1,2-	20MR
21	Mina/4/pmf/maya/yaco/3/ CO693591/CTK-	11LR-Res-207	2+	80S-MS
22	Saulesku 44/tr510222	8EYT-SA -9908	2+	80MS
23	#293	*Tr. aestivum* var. *erythrospermum* Korn.)		80S
24	#2216	*Tr. aestivum* var. *lutescens*	2+	60S
25	#288	*Tr. aestivum*	2+	70S
26	#211	*Tr. aestivum* var. *lutescens*	2	40MS
27	#302	*Tr. aestivum*	2	20MS
28	#202	*Tr. aestivum* var . *ferrugineum*	2	20MS
	Bezostaya 1		3+	90S-MS

References

Anonymous, (2008). Wheat Rust Disease Global Programme. Food and Agriculture Organization of the United Nations. Rome, 45 p.

Bariana H S (2008). Stem rust resistance in wheat. Proceedings of the International Conference on wheat stem rust Ug99. pp.20-24

Beteselassie N, Fininsa C and Badebo A. (2006). Sources of stem rust resistance in Ethiopian tetraploid wheat accessions. African Crop Science Journal, Vol. 15, No. 1, pp. 51 -57

Brown-Guerda G L, Jil B S, Bockus W W, Cox T S Hatchett J H, Leath S, Peterson C J, Thomas J B, Zwer P K (1996). Evaluation of a collection of wild timopheevi wheat for resistance to disease and arthropod pests. Plant diseases 80 :928-933

Dekaprelevich L L (1961). Die Art Triticum macha Dek et Men. im Lichte neuster Untersuchungen uber die Herkunft der Hexaploiden Weizen. Z. Pflanzenzuchtg. 45:17-30.

Dekaprelevich L L and Naskidashvili P P (1976). Triticum persicum v. stramineum, genetic source of resistance to yellow and brown rust [Georgian]. Soobsccheniya Akademii Nauk Gruzinskoi Ssr. 82:689-691.

Knott D R and Zang H T (1990). Leaf rust resistance in durum wheat and its relatives. In: Wheat Genetic Resources: Meeting Diverse Needs, Srivastava, J.P. and Damania, A.B. (eds). John Wileyand Sons, Chichester, UK, pp. 311-316.

McIntosh R A and Guarfas J (1971). Triticun timopheevi as a source of resistance to wheat stem rust. Z.Pfazenzucht, 66:240-248

Menabde V L (1948). Wheats of Georgia. Georgian Academy of Sciences Press, Tbilisi, 267p.

Naskidashvili P, Sikharulidze M, Chernish E (1983). Breeding of wheat in Georgia. Tbilisi,

Naskidashvili P, Iashagashvili G, Kevkhishvili V (1993). Valuable contribution of Georgian endemics and landraces in the breeding.(In Georgian). Tbilisi, Georgia, 40p.

Peterson R F, Campbell A B, and Hannah A E (1948). A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. Canadian Journal of Research 26: 496-500.

Pretorius Z A, Singh R P, Wagoire W and Peyne T (2000). Detection of virulence to wheat stem rust resistance gene Sr31in Puccinia graminis in Uganda. Plant Disease, 84:203

Roelfs A P and Martens J W (1988). An international system of nomenclature for Puccinia graminis f.sp. tritici. Phytopathology, 78:526-533.

Roelfs A P, Singh R P, Saari E E (1992). Rust Diseases of Wheat. Concepts and methods of Disease Management, Mexico, P.F.CIMMYT, pp.81.

Sikharulidze Z, Natsarishvili K, Mgeladze L and R Dumbadze (2013). Wheat stem rust research in Georgia. BGRI Technical Workshop, 8 - 21, August, 2013, India, New Dehli, Abstract book, p.94

Stakman E C, Stewart D M and Loeggering W Q (1962). Identification of physiologica races of Puccinia graminis var. tritici. US.Dept. Agri. ASR E617: 53pp.

Tyryshkin L G, Klesova M A, Kovaleva M A, Lebedeva T V, Zuev E V, Brykova N, Gashimov M E (2011). Current status of bread wheat and its relatives from VIR collection study for effective resistance to fungal diseases Proceedings of 8th wheat conference, 1-4 June. Petersburg, Russia

Tomerlin J R, El-Morshidy M A, Moseman J G, Baenziger P S and Kimber G (1984). Resistance to Erysiphe graminis f. sp. tritici, Puccinia recondita f. sp. tritici, and Septoria nodorum in wild Triticum species . Plant Dis. 68:10-13.

Wanuera R (2008). Status and impact of Ug99 in Kenya. Procc. International Conference on wheat stem rust Ug99. p 9-11