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Monitoring of Cereal rusts in Georgia in 2009-2013

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ABSTRACT: Extensive surveys were undertaken throughout six geographic zones of Georgia during 2009-2013. Visual inspections were made in farm fields, roadsides and breeding stations. Except for 2012 the cropping seasons 2009-2013 in Georgia were favorable for yellow rust development. Stripe rust occurred in 79% of the fields surveyed. Severe epidemics (>40% severity) occurred in the May and early June in 2009 and 2010. Incidence and severity levels of yellow rust in 2011-2013 were much lower than in previous years. Trace of yellow rust was observed in 2012 due to drought and hot dry weather in early spring. Wheat stem rust and leaf rust were found in 55% and 59% of the fields observed, respectively. The mean incidence of leaf rust ranged from 0.3% to 17.2%. Stem rust occurred with low intensity in the majority observed locations except Meskheti and Javakheti zones. Its overall mean incidence varied from 1% to 16.5%;

Key words: wheat, barley, rusts, incidence, severity

INTRODUCTION

It is known, that Georgia is a country of origin of cereals. At the same time it is distinguished by a diversity of a number of unique endemic species and old local varieties. However, cereal sowing areas have significantly reduced (from 400 to 50 thousand ha) after the collapse of the Soviet Union. The diversity of geographic zones in Georgia and co-evolution of the crop and its pathogens have created ideal conditions for diversification of plant pathogens. Partly for this reason, and partly because of the ravages of the economic difficulties over the past 20 years, the output of almost all traditional agricultural crops in Georgia is severely depressed. The average yield of cereals has been rather low, about 1.5 ton/ha.

Among the wide spectrum of cereal diseases causing significant yield losses, the rusts are the most important. The rusts of cereals (*Puccinia graminis f.sp. tritici, Puccinia triticina f.sp. tritici, Puccinia striiformiis f.sp. tritici, Puccinia coronata f.sp. avenae)* have been a scourge on humankind since the beginning of historical time. Many epidemics have been recorded over past 150 years in European countries, USA and Georgia, also (Borlaug, 2005; Shoshiashvili *et al.,* 1970). All four rusts are presented essentially everywhere where cereals are grown. Their importance from area to area depends on the weather conditions and also on the degree of cultivar resistance.

The disease surveys are an important component of integrated disease management. The disease surveys give producers advanced notice of potential disease problems and provide an incentive to take the necessary monitoring, preventative and control measures.

This paper compiles the annual survey results during 2009-2013 to report the incidence and severity levels of yellow rust, stem rust, leaf rust and crown rust of cereals in Georgia.

MATERIAL AND METHODS

The observations of wheat, barley and oat fields were conducted in 2009-2013 in the different geographic zones of Georgia: Imereti hill (elevation 500-1000m) with humid subtropics of Western Georgia with warm winter and hot summer; Shida Kartli plain (elevation 500-1000m), Kvemo Kartli plain (1000-1500m) and Kakheti (elevation 500-1000m) with continental subtropics of Eastern Georgia and dry subtropics with steppe moderate cold winter and hot long summer; Meskheti (elevation 1000-1500m) and Javakheti (1500-2000m) with continental climate of South mountain Georgia, with dry steppe and long warm summer.

Route observations of cereal fields and collection of infected samples were conducted according to standardized protocols for international rust surveillance system and methods used in surveys (Yahyaoui *et al*, 2003, Knott, 1989). Such investigations were carried out according to the previously designed plan. Cereal fields were selected at random at approximately 50-100 km intervals, depending on the frequency of the crop sowings in the region. Investigations were carried out during the period of plant vegetation, especially in critical phases of disease development. The top, middle and central parts of fields were inspected where plant groups (20 plants) were observed in five different points; main values of disease (incidence and severity) were visually recorded.

Incidence (%) - proportion of infected plants/ total plants assessed. Severity (%) was estimated on the whole plants, on the two upper leaves or on flag leaf according to area of the infected plant surface. The modified Cobb scale (Peterson *et al.*, 1948) was used to determine the percentage of possible tissue rusted. Incidence and 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). During observations the GPS was used to determine the coordinates of the survey location: decimal degrees for both latitude and longitude and the elevation.

RESULTS AND DISCUSSION

A total of 597 cereal fields were monitored in 20 regions of seven geographic zones of Georgia. The cereal fields were located at elevation: 170-1739 m. Surveys were conducted from early April prior to the beginning of August.

A. Survey of Wheat rusts

A total of 414 fields of winter wheat were observed in the major wheat production regions including the farmer fields and breeding stations. Observations showed that stem rust, yellow rust and leaf rust of wheat were distributed nearly in all zones with different intensity (Table 1). Incidence and severity of rusts were ranged between 1-100% depending on climate conditions, observation date, place and cultivar.

From all three rusts the predominant disease over all locations and years was yellow rust. Yellow rust was indicated in 69% of the surveyed fields. Incidence and severity of yellow rust varied between 0% -74.8%. Overall mean incidence and severity within investigated zones and years was 19% and 22%, respectively. In 2009, favorable conditions resulted in serious outbreaks of yellow rust in several countries in the world including Georgia. In the most regions of Georgia, disease mean incidence was moderate (29.6-30.5%) and high (48.2-60%). Favorable conditions with mild winter, warm and wet spring and adequate rainfall have continued into 2010 in several CWANA (Central and west Asia and North Africa) countries (Syria, Iraq, Turkey, Morocco, Uzbekistan, Lebanon, Azerbaijan), resulting in early outbreaks of yellow rust (www.globalrust.org). Presence of susceptible cultivars and favorable weather conditions were especially conducive for yellow rust development in Georgia in 2010. Besides, the initial inoculum of yellow rust was abundant as urediniospores of *Puccinia striiformis* survived successfully. It is known that in Georgia *Puccinia striiformis* overwinters by resting urediniomycelia on winter wheat sowings and wild grasses (Paichadze, 1975).The first symptoms of yellow rust were indicated in middle March and by early April, 2010. In late May and early June severe levels of stripe rust were recorded on susceptible varieties. The highest mean incidence and severity were recorded in the Kakheti (74.8% and 84.6%) and Kvemo Cartli (70%-68.2%) zones. The severity of yellow rust reached 100% on some varieties and locations. Nevertheless, some of wheat fields have been treated with fungicide, yield losses due to yellow rust epidemic was significant in 2010. In 2011-2013 incidence of yellow rust decreased. Very low level of infection (0.8%) was recorded in 2012 due to drought and high air temperature in May.

Wheat stem rust was found in 55% of the fields examined with overall mean incidence varying from 1.1% to 16.5% by zones; Stem rust occurred rarely in the majority observed locations except Meskheti zone (overall mean incidence 16.5% and severity 20.1%.), where Barberry bushes are grown widely. Overall mean incidence and severity within surveyed zones and years was 8% and 11%, respectively**.**

Wheat leaf rust was presented in nearly all investigated areas with low incidence and severity. Leaf rust was recorded in 59% of the wheat fields observed during five years with overall mean disease incidence ranged from 0.3% to 17.2%. Moderate level of leaf rust incidence (20.5%) was indicated only in Imereti hill in 2009 and Kakheti (23.6%) in 2013. Overall mean incidence and severity within survey period was 5% and 7%, respectively**.**

The bread wheat cultivars (Bezostaya 1, Spartanka, Krasnodarskaya 99, Pobeda 50, Umanka, Kupava, Rusa, Gorlitsa, Batko, Sila, Zastava, , Moskvich, Vita, Fisht, Tania) were commonly grown in Georgia.. Among them Russian variety Bezostaya 1 occupied the majority of the commercial fields. Also, cultivars Copper and Jagger were produced on large areas in 2011-2013. Copper was moderately resistant to yellow rust, leaf rust and stem rust, Jagger and Bezostaya 1 was moderately susceptible to all three rusts. Nearly all Russian cultivars were moderately susceptible to rusts with different severity. 16 Georgian cultivars were observed on breeding stations located in Shida Kartli Plain, Kvemo Kartli plain and Kakheti in flowering-milk ripe stage. Yellow rust and leaf rust distributed more widely than and stem rust. Incidence and severity of rusts varied between 1-50% and 5-80% on Georgian cultivars Vardzia, Almasi, Akhaltsikhis tsiteli doli, Korboulis tetri doli, Megobroba, Deda, Mukhrani, Dika 9/14, Jinvali, Zedazeni, Bagrationi, Aisi. Georgian cultivars Mtskheta 1, Khulugo, Tetri Iphkli and Shavpkha showed moderate resistant to all three rusts. Wheat endemic species *Tr.Cartlicum-Dika, Tr.Timopheevi-Chelta zanduri, Tr.Macha, Tr.Georgicum-Kolkhuri asli, and Tr.monococcum* – gvatsa zanduri,Macha, were also resistant to all three rusts.

Table 1: Incidence (%) and severity (%) levels of yellow rust, stem rust and leaf rust in Georgia in 2009-2013.

Geographic zones	Disease	Years										Overall mean values by zones	
		2009		2010		2011		2012		2013			
		Incidence	Severity	Incidence	Severity	Incidence	Severity	Incidence	Severity	Incidence	Severity	Incidence	Severity
Imereti Hill	YR	10.1	15	24.3	20.4	-	-	-	-	-	-	**17.2**	**17.7**
	SR	14.0	20.2	10.4	15.5	-	-	-	-	-	-	**12.2**	**17.8**
	LR	20.5	24.8	15.0	12.0	-	-	-	-	-	-	**17.7**	**18.4**
Shida Kartli Plain	YR	60	65	42.5	58.4	3.1	5	0.5	0.8	0.7	1.0	**21.4**	**26.1**
	SR	4.5	10.5	12.4	16.4	6.7	10.2	9.4	8.5	0.2	1.6	**6.6**	**9.4**
	LR	3.6	8.4	5	10	0.7	5	0	0	8.3	10.2	**3.5**	**6.7**
Kvemo Kartli Plain	YR	30.5	40	70	68.2	1.2	5	1	1	30.0	34.6	**26.3**	**29.7**
	SR	0	0	1	5	3.5	10	0.5	0.8	0.3	5	**1.1**	**4.2**
	LR	0	0	0	0	0.2	5	0.3	0.5	16.3	20	**3.3**	**5.1**
Kakheti Valley	YR	48.2	60.0	74.8	84.6	0.5	5	1.5	1.8	3.7	5	**25.3**	**31.3**
	SR	4.8	6.5	0	0	1.4	4.2	1.3	1.4	0.1	1	**1.3**	**2.6**
	LR	5.2	8.4	1	5	0.5	4.6	0.8	1.5	23.6	25.1	**6.1**	**8.9**
Meskheti	YR	29.6	34.2	28.5	37.4	6.5	10.2	0	0	4.5	5.8	**13.8**	**17.5**
	SR	34.4	40	12.8	15	4	10	30.4	35	1	0.4	**16.5**	**20.1**
	LR	0	0	1	5	0.6	3	0	0	0	0	**0.3**	**1.6**
Djavakheti	YR	18	25	20.8	24.6	3.1	5	1.5	1.8	0	0	**8.4**	**11.3**
	SR	54.8	50	5	10	6.7	15	0.5	1	0	0	**13.4**	**15.2**
	LR	5	10	5	15	0.7	3	0	0	0	0	**2.1**	**5.6**
Overall mean values by years	**YR**	**32.7**	**39.9**	**43.5**	**48.9**	**2.9**	**6 .0**	**0.8**	**0.9**	**7.8**	**9.3**		
	SR	**18.8**	**21.2**	**6.9**	**10.3**	**4.5**	**9.9**	**7.0**	**7.8**	**0.2**	**1.8**		
	LR	**2.8**	**5.2**	**4.4**	**8.3**	**0.7**	**4.1**	**0.2**	**0.3**	**9.6**	**11.0**		
Overall mean values within surveys	**YR**											**19.0**	**22.0**
	SR											**7.0**	**11.0**
	LR											**5.0**	**7.0**

B. Survey of Barley and oat rusts

During surveys 134 barley and 49 oat fields were investigated in Western (Kolkhis lowland, Imereti hill), Southern (Shida Kartli plain, Kvemo Kartli plain, Kakheti) and Eastern Georgia (Mesckheti, Javakheti)). Accordance with the survey results of the 134 barley fields examined, rusts were occurred in 102 fields. Table 2 shows that moderate incidence of barley leaf rust and stem rust was indicated in the most investigated zones on commonly grown Georgian cultivar "Akhaltesli". Incidence and severity of Stem and Leaf rust were high in Mtskheta breeding station on varieties Ebson, Tolar, Balaz and Sebastin. High incidence of leaf rust was found on Kakheti barley sowings. Yellow rust of barley was found only in Shida kartli and Javakheti zones with moderate and low levels, respectively. Crown rust of oat was found in all investigated area with incidence ranged from low to high level. High incidence of crown rust with severity 16% was indicated in Imereti hill and Shida kartli zones. Stem rust of oat occurred only in Kakheti and Meskheti zones with low incidence and severity.

Table 2: Survey of barley and oat rusts in Georgia.

Geographical zones	Host plant	Incidence / severity level of diseases			
		Stem rust	Crown rust	Leaf rust	Stripe rust
Imereti hill	Barley	M/M		H/H	0
	Oat	0	H/M		
Kolkhis lowland	Oat	0	M/M	-	-
Shida Kartli plain	Barley	M/M		M/M	0
	Oat		H/H		
Kvemo Kartli plain	Barley	L/L	-	L/M	L/L
	Oat		M/M		
Kakheti	Barley	M/L	-	M/M	0
	Oat	L/L	L/M		
Mesckheti	Barley	M/M	-	M/M	0
	Oat	L/L	ML		
Djavakheti	Barley	M/L	L/L	M/L	M/L
	Oat		M/L		

Note: *L (low) = less than 20% M (moderate) = 20-40% H (high) = more than 40%*

Thus, notwithstanding the climate diversity of geographic zone, nearly all cereal rusts occurred in Georgia with different intensity. Yellow rust of wheat in comparison with other rust species is characterized as more widely spread disease. Incidence of stem rust was less than leaf rust. Data from over survey sites were incorporated into a centralized database of Global Cereal Rust Monitoring System. GCRMS provides information that is used routinely by national partners to guide decisions regarding control and management of cereal rusts.

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