RESPONSE OF SOME VARIETIES AND GENOTYPES OF TRITICALE (*TRITICOSECALE* WITTM.) TO THE ATTACK OF *PUCCINIA STRIIFORMIS* WEST. FUNGUS IN WESTERN ROMANIA

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Abstract

Nowadays the species Triticosecale has started to gain ground in Banatului Plain and in Romania, mainly due to the increased yields of biomass and grains in comparison with other cereals and due to the high adaptability to different climate and soil conditions. Triticale is interesting for inbreeding due to its features mainly as fodder plant. Triticale proved during time that it is sensitive to the attack of the cereals pathogens. In Banatului Plain triticale is sensitive to the attack of the fungi Puccinia striiformis (yellow stripe rust) and Drechslera tritici repentis (tan spot). In Banatului Plain tan spot appears in every year, but yellow stripe rust isn't appearing yearly due to its demand for special conditions of temperature and moisture. This research is a case study developed in the spring of year 2018 when climate conditions were favourable to the development of the fungus Puccinia striiformis. Thus, there was monitored an experimental filed comprising nine lines and one variety of triticale in conditions of natural infection. There was evaluated the resistance to this dangerous pathogen of the cereals. The biological material used was: KT 1430 - 10, KWT 13069, 202.567, KT 390, 10T70126, 08TF01, 141 TRICAL, WINTER MAX and TM 01. Attack severity was comprised between 10% (line 10 T 70126) and 90% in line 202.567 that had proved to be the most sensitive from entire experimental field. Frequency of the plants with symptoms was maximal in five triticale lines from experience (F = 100%). Winter Max variety was highlighted by a low attack frequency of 5% plants with symptoms, the lowest from the experiment. All the analysed genotypes were reacted differently to the pathogen attack. Five triticale lines have manifested high sensitivity (FS) to the attack of Puccinia striiformis. Triticale lines 08TF01 and 141Trical and the variety Winter Max have manifested a reaction of sensitivity to the pathogen (S). Moderate resistance was noticed in only one triticale line from experimental field, respectively the line 10T70126.

Key words: *Puccinia striiformis, resistance, triticale, lines, yellow stripe rust, triticosecale, varieties*

INTRODUCTION

Triticale (X *Triticosecale* Wittmack) is an amfiploide between wheat and rye framed in *Poales* order, *Poaceae* family, *Triticeae* tribe. The base forms in that triticale is framed are: octoploid triticale with 56 chromosomes in somatic cells (42 from wheat and 14 from rye), hexaploid triticale with 42 chromosomes (28 from wheat and 14 from rye) and tetraploid triticale with 28 chromosomes (14 from wheat and 14 from rye). According with ROMAN G. V. *et al*. (2011) the hexaploid forms proved to be the most stable, fertile and productive.

Even isn't cultivated by long time, triticale is expanding the cultivated surface doe to the capacity of producing great amounts of biomass and grains in comparison with other cereals. Other important aspect is that it can be cultivated in various climate and soil conditions [HINOJOSA *et al.*, 2002]. According with FAO (2003) data, nowadays triticale is cultivated on about 3 million hectares worldwide. In Romania the surface cultivated with triticale was about 40 – 50 thousand hectares in 2014, with an increasing trend in the cultivated area [IMBREA F.,

2014]. The main use of the yield is animal feeding [SAADE, 1995]. Triticale is very proper for forage due to its nutrients, the grains being able to replace maize grains in the feeding of monogastric livestock and poultry [VARUGHESE *et al*., 1996b; SAADE, 1995]. Contrary to the successful use in the animal feeding, it is less used for human consumption due to the low bakery features [PEÑA, 1994]. Triticale grains are dark coloured and have shrivelled aspect that limits its' use for bread. Triticale flour is used extremely rare at the preparation of some biscuits.

Resistance against pathogens of the species *Triticosecale* seemed to be good at the beginning of its cultivation, but once the cultivated surfaces increased appeared diseases problems. Nowadays in triticale crops appear more frequently the pathogens specific for wheat and rye, some of them manifesting a relatively increased virulence [MERGOUM, 1994]. Resistance reaction to pathogens is a combined resistance inherited from genitors. Many researches highlight vulnerability and sensitivity in triticale to several plant pathogens as are the following: *Puccinia striiformis, Drechslera tritici repentis, Septoria nodorum* and *Bipolaris sorokiniana* [SAARI *et al*., 1986; MARTENS *et al.,* 1988; ZILLINSKY, 1983; SKOVMAND *et al*., 1984]. From the mentioned fungi species in Banat area were distinguished by high aggressivity and virulence on triticale *Puccinia striiformis* and *Drechslera tritici repentis.*

High virulence of the fungus *Puccinia striiformis* on triticale, but also on wheat was determined and reported by many plant pathologists. Epidemics of yellow stripe rust produce great harvest losses in triticale and in wheat too [SINGH & SAARI 1991; WIESE, 1987; GUEDES-PINTO H. *et al*., 1996]. Some researchers assume that attack intensity on leaves of only 10% determinates harvest losses of 3% [SCHEVCHENKO, 1985]. Thus, there was known regarding triticale that it is resistant to the rusts producing fungi, mainly yellow stripe rust. Researches from Germany, Poland and Russia developed during 1988 - 2009 period bring in attention massive attacks of yellow stripe rust and other diseases that have determined significant harvest loses in triticale [SCHINKEL, 2002; SODKIEWICZ *ET* STRZEMBICKA, 2004; MIKHAILOVA *et al.,* 2009; MERGOUM *et al.,* 2009].

High fungus aggressivity on triticale and on wheat is due to the new fungal races adapted to higher temperatures comparative with the ones normally preferred by this pathogen. These aspects have been observed in 1999 in areas from Northern, Central and Eastern America [CHEN, 2005; CHEN *et al*., 2010 cited by RANDHAWA H. *et al.*, 2012]. According with CHEN *et al*. (2010), in 2006 have been registered 18 races of the fungus in Pacific Northwestern SUA (five of them for the first time). *Puccinia striiformis* presents many specialised forms: on wheat (*Puccinia striiformis f. sp. tritici*), on barley *P. striiformis f. sp. hordei*, on rye *P. striiformis f. sp. secalis*, on cocksfoot *P. striiformis f. sp. dactylidis*. At these specialised forms are included those forms existent on spontaneous grasses and those from triticale [POPESCU G., 2005; LINE, 2003; HOVMØLLER & JUSTESEN 2007; WELLINGS, 2007]. In Romania, *Puccinia striiformis* presents 13 physiologic races together with the specialised forms mentioned above, they are grouped in three types. These races have been identified during the three epidemic of yellow stripe rust from Romania during 1960 - 1989 [POPESCU G., 2005]. According with STUBBS (1988) and HOVMØLLER & JUSTESEN (2007) the most virulent races on triticale have been reported in Europe, South America, Africa and China.

In this work there has been analysed the response of nine genotypes and varieties of triticale to the attack of *Puccinia striiformis* fungus in condition of natural infection. In Romania yellow stripe rust appears only when climatic conditions are favourable, respectively low temperatures in spring (10 - 15^0C) and high amounts of rainfall during the vegetation period of the cereals. The spring in 2018 was extremely favourable to the infections with *Puccinia striiformis* both in wheat and triticale.

MATERIAL AND METHOD

Field observations were developed during the spring in 2018. The triticale varieties and lines analysed there were the following: KT 1430 - 10, KWT 13069, 202.567, KT 390, 10T70126, 08TF01, 141 TRICAL, WINTER MAX and TM 01. The meteorological data were taken from Timişoara Meteorological Station. The considered parameters were: temperature, rainfall amount and atmospheric humidity. The biological material, respectively eight lines and one variety have been organized in the experimental field according with the randomised blocks method with three replicates. Every plot had 10 m length and 1 m width. The data collection for the incidence and attack of the fungus *Puccinia striiformis* was developed on the background of natural infection using the classic formulas from plant pathology. Climate conditions from the year 2018 were favourable for the development of the fungus *Puccinia striiformis* in Banatului Plain. Attack intensity or severity on leaves was registered on 0 – 5 scale there being calculated the average rate of the foliar surface covered with stripe rust pustules.

Obtained results were analysed using the resistance scale in yellow stripe rust as it follows: 0 - 1% = highly resistant; 2 - 5% = resistant; 6 - 10% = medium resistant; 11 - 15% = intermediate resistance; 16 - 20% = medium sensitivity; 21 - 40% = sensitivity; over 40% = highly sensitive [after MC CALLUM *et al.*, 2007a].

Statistical analysis of the research results was realised using the statistical method ANOVA.

RESULTS AND DISCUSSIONS

Climatic conditions from the spring of the year 2018 in Banatului Plain (Timişoara) were very favourable to the infections with *Puccinia striiformis*. In this year yellow stripe rust was present in cereal crops, mainly on wheat and triticale.

Rainfall amount from the months January, February, March, April, May and June was 330.7 mm from the multiannual amount of the area, respectively 592 mm. The rainfall amount from March – June period was 227.5 mm, with 11.9 mm less comparative with multiannual average, an insignificant deficit.

The registered temperatures show deviations comparative with the multiannual averages, the thermal regime being characterised by higher monthly average temperatures. Exceptions were registered in March when the deviation comparative with the multiannual average was negative (-1.44 ºC). In April, May and June the deviations had positive values as it follows: 5.1ºC (April), 3.6ºC (May) and 1.7ºC (June). The monthly averages were comprised between 4.6ºC (March) and 21.3ºC (June). The maxim values registered during the analysed interval were comprised between 9 and 27ºC and the minim values were between 0 and 15ºC.

Climatic analysis of the period when was developed the research show that the fungus *Puccinia striiformis* had optimal conditions for infection and development. There is well known that in Romania yellow stripe rust appears sporadically only in the years with favourable climate conditions. The appearance of the infections in the experimental field of triticale leaded to the initiation of the research regarding the resistance of several triticale genotypes to the attack of *Puccinia striiformis* in natural conditions of infection. Even the results are reported for only one year, the great pressure of the infection supported by the climatic factors is determining the accuracy of this research.

It is well known that the presence of the fungus *Puccinia striiformis* worldwide is limited by the optimal temperature interval that allows the development of the pathogen. The same situation is in Romania, the yellow stripe rust appearing only during the humid and cold

springs. *Puccinia striiformis* demand optimal temperatures comprised between 9 and 15ºC and maxim of 20 – 23ºC for the spores germination, penetration, development and spore production.

Table 1

Severity attack of the fungus *Puccinia striiformis* on triticale lines and varieties monitored in 2018

Variety/Line	Density plant/m^2	Frequency attacked plants (F%)	Attack severity (I%)	Attack degree (GA%)
KT 1430-10	420	100	74	74
KWT 13069	424	100	70	70
202.567	564	100	90	90
KT 390	476	100	66	66
10 T 70126	388	7.73	10	0.773
08TF01	356	7.02	36	2.527
141 Trical	392	12.75	30	3.825
Winter Max	400	5	40	2
TM 01	352	100	70	70

Table 2

Evaluation of the resistance of the lines and varieties of triticale depending by the attack severity of the fungus *Puccinia striiformis* on leaves in the climate conditions from 2018

Variety/line	***Attack severity (I%)***	***Difference/ Significance***	***Resistance evaluation***
202.567	***90***	***-***	***FS***
KT 1430-10	74	***-16 ^{0}***	***FS***
KWT 13069	70	***-20 ^{00}***	***FS***
KT 390	66	***-24 ^{000}***	***FS***
10 T 70126	10	***-80 ^{000}***	***RM***
08TF01	36	***-54 ^{000}***	***S***
141 Tricale	30	***-60 ^{000}***	***S***
Winter Max	40	***-50 ^{000}***	***S***
TM 01	70	***-20 ^{00}***	***FS***
LSD 5% = 12.389; LSD 0.1% = 17.064; LSD 0.1% = 23.493 ***FS – highly sensitive; RM – medium resistant; S - sensitive.***			

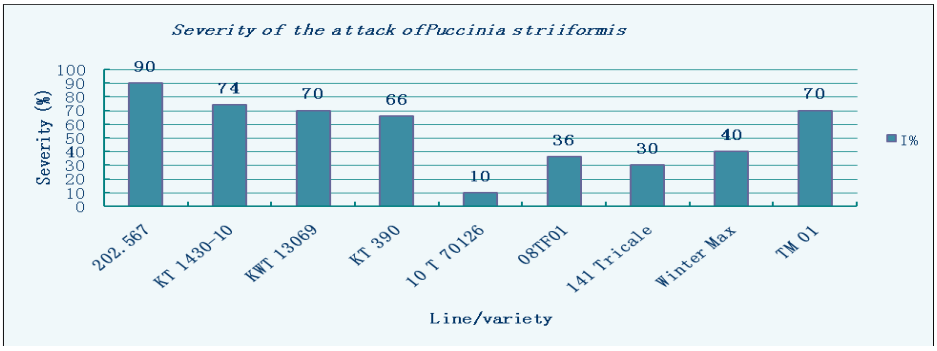

Figure 1. Severity of the attack of the fungus *Puccinia striiformis* in *Triticale* (2018)

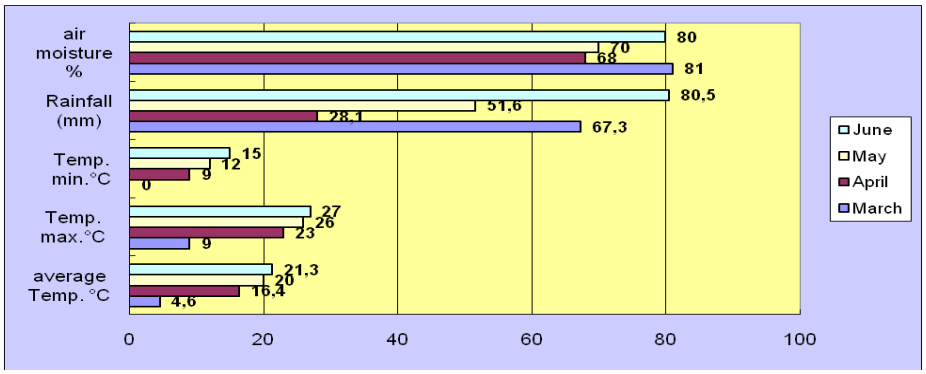

Figure 2. Climate parameters during March-June 2018

A B

Figure 3. A and B: Yellow rust pustules on triticale leaves [COTUNA OTILIA, 2018]

The minimal temperatures that allow the germination of the spores and the penetration of the plant cell walls are comprised between 0 – 5ºC. Free water is essential for the germination of the spores and for penetration of the tissue, but is less important for the fungus development and spore formation. Regarding light impact on the fungus, it is more pretentious preferring low light during the germination and penetration period and more light for development and spore formation [ROELFS A. P. *et al*., 1992].

In the experimental field, first symptoms of yellow stripe rust were noticed in the second part of the spring in 2018 (figure 3). The yellow pustules in parallel straight rows were noticed first on leaves and after have spread on spikes too (in several lines). The analysed triticale genotypes were responded differently to the pathogen attack. The infection severity varied between 10% in the line 10 T 70126 and 90% in the line 202.567, the last one being the most sensitive from the analysed genotypes. In four triticale lines (KT 390, KWT 13069, TM 01 and KT 1430 - 10) attack severity was comprised between 66 and 74% (rate of leaf surface covered with pustules). Attack severity in the lines 08 TF01 and 141 Trical were lower than 36%, and in Winter Max variety was 40% (Table 1).

The incidence of the disease was maxim in five triticale lines from the analysed material

(F = 100%). In contrast, Winter Max variety had a low attack frequency, respectively 5% plants with symptoms, this being the lowest value from the analysed triticale genotypes. In the other analysed triticale varieties (10 T 70126, 08 TF 01 and 141 Trical) the frequency of the attacked plants was comprised between 7.02% and 12.75%. There can be noticed that in these three lines and the only one variety from the research plot where the attack incidence was lower than 12%, the severity of the infection was lower than 40%. The situation was totally different in the case of the lines where attack severity was very high (66 – 90%), the incidence of the plants with symptoms being maximal (F =100%) as is shown in table 1. The great difference can be attributed to plant density on square meter and to genetic resistance. The genotypes that have registered lowest attack severity and frequency values have a density lower than 400 plants/m^2, and the other lines analysed have a density greater than 400 plants/m^2. The most attacked line from the experiment (F = 100; I = 90%) have a density of 564 plants /m^2 (table 1).

The best response to the pathogen attack was registered in the case of the line 10T70126 (I = 10%). According with the obtained results there can be assumed that the attack degree was high in five triticale lines (equal with the attack severity) and decreased in the other lines and the analysed variety that have the lowest attack frequency (table 1).

The evaluation of the resistance was assessed by the analysing the results using the resistance scale regarding the attack severity [after Mc Callum *et al.*, 2007a]. According to the resistance scale, five triticale lines were reacted as highly sensitive (FS) to the attack of the fungus *Puccinia striiformis* (table 2). Two lines and the analysed variety (08TF01, 141Trical and Winter Max) were sensitive to the pathogen (S). The only line from research that manifested moderate resistance (RM) was 10T70126.

CONCLUSIONS

The climate changes at that we are witnesses in the last years could determinate the incidence of yellow stripe rust in Banat area in every year, not only sporadically as it happens now. In this kind of scenario yellow stripe rust will be a serious threat for the cereal crops near to the other pathogens, increasing the risk of yield loses. The mild winters and cool springs could lead to the increase of the inoculus source of the fungus *Puccinia striiformis* and to the appearance of the infections early in season in triticale and wheat. Former researches from the years with yellow stripe rust conducted to the conclusion that the triticale lines and varieties are most sensitive to this pathogen in comparison with wheat genotypes that are more resistant.

Severity of the infection with *Puccinia striiformis* in 2018 in the analysed genotypes highlighted the low resistance to the fungus attack, eight of them being highly sensitive to the pathogen. Only one line manifested moderate resistance to the pathogen (10T70126) it being useful in triticale inbreeding process.

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