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A SOLUTION FOR ECONOMICAL AND SAFE WHEAT PROTECTION FROM PARASITES

Abstract

Sum of stem length, spike capacity and SAGR transformed values (1-5) on May 25 was highly correlated to green leaf area disappearance (GLAD) of the varieties. Treatment at 06.03.2011 was most efficient but obvious followed by fungicide residua, while early one at 05.08.2012 was economically contra effective explained by reduced antagonistic facultative parasites activity. The model for forecasting maximal attack intensity of parasites and grain yield losses was adequate in both years for the solution about fungicide treatment rent ability. The economical and safe time for fungicide application were vice versed. Solution was found in growing varieties with SAGR value below 3 and sum of on GLAD influential factors at least 12.

Key words: *wheat parasites, forecasting model, fungicide, Puccina spp.*

INTRODUCTION

Wheat parasites, especially *Puccinia triticina*, have been considered as responsible for major cumulative yield losses (Roelfs and Bushnell, 1985). According to Khan et al. (1997), each percent of green area cover leads to a proportional total yield loss. Each 10% of total parasites' severity on last two leaves caused approximately 3.5% grain yield loss in a semiarid region (Jerković and Prijić, 2008). The parasite mentioned above has the highest and fastest spread and infection potential in wheat. The most efficient protection was achieved by employing resistance genes (Jerković, 1995). How the parasitic population overcame the resistance was extensively described and the responsible genes were distinguished as specific or nonspecific to parasite races

(Nelson, 1978). Forecasting models for leaf rust development were based on the parasite's epidemiology (Zadoks et al., 1985; Reinink, 1986) and host resistance (Jerković and Putnik-Delić, 2004). The latter model was regionally successful, particularly in years without continual humid periods. So, the next forecasting model involved a relationship with antagonists, *Pyrenophora tritici repentis* (Jevtić, 2001; Jerković et al., 2005) and *Septoria tritici* (Jerković, 2008). The degree of nonspecific resistance to leaf rust in field was defined according to stem growth ratio (Jerković and Putnik-Delić, 2009b) which gave the previous model a chance to be transferred into practice (Jerković and Prijić, 2010). The fungicide application by 12-m sprayer boom caused damage corresponding to 5-7% of the grain yield, which set the cost of treatment at about 10% of the grain yield (Jerković and Prijić, 2009a). A relatively short period of grain filling in semiarid regions and simultaneous optimal period for the development of prevalent parasites posed the fungicide application as a problem because the resting time of each fungicide was not shorter than thirty days (Osborne and Stein, 2009).

The aim of the study was to find a solution for permanent, safe and economical wheat protection against parasites in particular semiarid regions by employing a model for green leaf area disappearance forecast, different times for fungicide application and a model for grain yield loss forecast.

MATERIAL AND METHOD

Several local varieties were tested in a specially designed 2-year trial in which the treated and control plots ($6m^2$) were distanced 2 m (Jerković, 1997). The sowing of 600 seed per m^2 was performed on November 3, 2010 and October 28, 2011 while the harvest was on June 30, 2011 and July 2, 2012. The treatment with a tebukonazol based fungicide was performed on June 3, 2011, while by metkonazol on May 8, 2012. Severities of *Puccinia triticina, Purenophora tritici repentis* and *Septoria tritici* on intermediate and last two leaves were estimated on May 25 and June 18 in both years and presented in percents. SAGR was defined as ratio between last two leaves and stem length. Maximal severity of the parasites on last two leaves was calculated according to the formula: 90 - |(SAGR x 100 – 50) x 2,5 + severity of *Pyrenophora tritici repentis* on middle leafs x 2) + severity of *Septoria tritici* on middle leafs x 0,5)| x latency period (1 when *Puccinia triticina* appeared before May 25, and 0,8 or below when after). The forecasted grain yield loss in percents was achieved value x 0,35. Time of green leaf area disappearance (GLAD) was correlated with sum of SAGR (grouped from 0,5 by adding 0,05), stem length (grouped from 50cm by adding 10cm) and number of spikelet's (grouped from 12 by adding 2) all transformed in 1-5 values and estimated at May 25 using first two tiller shoots. Maximal simultaneous appearance of facultative and obligate parasite was not presented as sum because of over covering by *Septoria tritici* and no development around *Pyrenophora tritici repentis* than calculated according to formula: (100 – sum of facultative parasites

ıtensity : 100) x severity of *Puccinia triticina* + sum of facultative parasites ıtensities.

RESULTS AND DISCUSSION

In 2011, grain yielding potential of the variety Sonata was 10% higher than that of Pobeda and 13% from Rapsodija. Higher SAGR and lower stem length resulted in lower grain yields. The variety Janja, because of a low stem height and lowest SAGR, expressed the leaf yellowing earlier than the other varieties which maintained the photosynthetic activity only in the flag leaf. The treatment performed on June 3 did not allow parasitic development until the end of the vegetation. In that way we avoided making mistakes in maximal grain yield potential assessment due to further parasite development. Varieties like Sonata and Kantata with GLAD factors sum 3+4+4, until nowadays potentially the highest yielding ones in the described region (Jerković and Prijić, 2009; 2010), appeared to be safely treated by fungicides before May 24, 2011 and May 21, 2012. The occurrence of facultative parasites on last two leaves caused a 3% error in comparison to the forecasted maximal severity for leaf rust. In 2010, the maximal error in grain yield loss estimate was 7%, related to the variety Rapsodija which had SAGR over 0.70, because of the occurrence of facultative parasites on two top leaves which were rust free. In 2011, the correlation between the realized and forecasted values was r=0.92. Average deviation from parasites' severity values were counted across real grain loss. The value of 0.35 was estimated at 2%, and consequently the average factor ranged from 0.35 to 0.355 with transgression from 0.30 to 0.38 (Tab. 1 and 2).

Table 1. Green leaf area disappearance factors

Variety	SAGR 2011	SAGR 2012	Stem length 2011	Stem length 2012	Spikelets number 2011	Spikelets number 2012	Sum of GLAD factors 2011 2012	GLAD 2011	GLAD 2012
	1		2		3		1 2 3		
Pesma	0.67		80		18 or 20		4+3+5=12	25.06	
Pobeda	0.67	0,70	90	74	16or18	16or18	4+4+3=11 5+2+3=10	23.06.	20.05.
Kantata	0.65	0,67	89	75	18	18	3+4+4=11 4+2+4=10	23.06.	20.05.
Sonata	0.64	0.66	88	65	18	18	3+4+4=11 4+2+4=10	23.06.	21.05.
NS 40S	0.61	0,67	81	68	18	18	3+4+4=11 4+2+4=10	23.06.	21.05.
Rapsodija	0.73	0,75	75	58	16	16	5+2+3=10 5+1+3=9	22.06.	18.05.
Simonida	0.68	0,70	80	65	16	16	4+3+3=10 5+2+3=9	21.06.	18.05.
Evropa 90	0.62	0,69	92	73	16	16	3+4+3=10 5+2+3=10	21.06.	20.05.
Janja	0.58		86		16 or18		3+4+3=10	22.06.	
Prima	0.64	0,67	70	50	16	14 or 16	3+2+3=9 4+1+2=6	19.06.	15.05.

Table 2. *Severity of prevalent parasites, forecasted values and grain lossess in 2011*

Variety	Grain losses in %/ grain yield t/ha 2011th	Max. attack of *Puccinia triticina* predicted by SAGR 2011th	*Pyrenophora tritici repentis* intensity on intermediate[1] and last leafs[2] 1	2	*Septoria tritici* on intermediate[1] and last leafs[2] 1	2	*Puccinia triticina* attack on last leafs	Forc-asted max. seve-rity of *P. ritici-na*	Sever. by yield loss/ Severiy across new formu-la
Pesma	11/8.9	50	5	5	10	10	20	28x0,8	32-27
Pobeda	18/8.6	48	5	10	10	15	30	33	50-48
Kantata	19/9.4	53	T	5	T	5	50	50	54-55
Rapsodija	11/8.5	42	5	10	15	15	10	25	30-32
Sonata	20/9.6	55	T	5	5	10	50	52	57-58
NS 40S	15/8.9	65	5	T	5	T	40	52x0,8	43-39
Simonida	10/8.9	48	5	5	10	10	25	35x0,8	30-36
Evropa 90	18/8.6	60	5	T	5	T	50	48	50-51
Janja	19/9.1	70	5	T	5	T	60	58	55-61
Prima	12/8,5	55	5	5	10	10	30	40	35-40

The green leaf area disappeared earlier in 2011 than in 2012, mostly because of reduced stem length, 17cm on average. SAGR values were generally increased on average to 0.696 and were for 0.36 higher than in the previous year (Tab. 1). Equal time of GLAD was achieved by different values of the estimated parameters in the two years, while same sums of parameters resulted in approximately or exactly the same date of GLAD. The differences between sums of GLAD factors were more variable in the varieties with a short stem (Tab. 1). The intensities of *Pyrenophora tritici repentis* and *Septoria tritici* at least doubled the maximal values from the year before on low and approximately the same on the two top leaves even in treated plots, which can be explained via infection by facultative parasites from control plots. This indicated a short efficiency period of the fungicide. When SAGR values and intensities of the facultative parasites were so increased, the occurrence of obligate parasite was not expected by the forecasting model, as achieved in the control. The toxin (Friesen et al., 2003; Stargiopoulos et al., 2003; Strelkov et al., 2003) amount reduced by early treatment allowed a slight obligate parasite occurrence, below 10% of the flag leaf area. Even in such years as 2012, the economic effect of the early treatment was found to be slight negative, bellow 2% of the grain yield. When SAGR values were like those in 2010 or 2011, the same directed consequences of the early treatment were predicted to be much strongly expressed. Generally, the yield was lower by 22% than in 2011 while the varieties were ranked the same with exception of the highest yielding one NS 40S, explainable by favorable position in the trial.

CONCLUSION

The safe and economical treatments were vice versed. New practical models for covering time of the green leaf area disappearance solved the problem of last safe gicide application as well as rent ability of the effort. The harmonized solution for manent economical and safe wheat protection after resistance of particular varieties s overcome was found in growing of these with GLAD sum of et least 12 adequate the treatment efficacy. SAGR value below 3 was suggested with aim to slow the ultative parasites fructification and spreading on upper leafs during the period with re probable continual humidity. The suggested had to be followed by obvious ferences between varieties according to specific resistance genes to leaf rust cause cause of sustainable seed supply and possibility of fungicide application in short riod after decision about rent ability.

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REŠENJE PREKO MODELA ZA EKONIMIČNU I BEZBEDNU ZAŠTITU PŠENICE OD PARAZITA

Apstrakt

Više sorti ozime pšenice su razlikovane 25.05. po visini stabla, kapacitetu klasa i SAGR definisanim kao količnik dužina dva poslednja kolenca i stabla. Suma transformisanih vrednosti pomenutih karaktera (1-5) je bila u jakoj korelaciji sa vremenom nestanka zelene lisne površine (GlAD). Tretman fungicidima 03.06.2011. je bio najefikasniji ali obavezno praćen reziduama sistemičnih fungicida, dok je ranija primena 08.05.2012. bila ekonomski kontraefektna. Pojava je objašnjiva preko redukovane proizvodnje toxina odgovornih za antagonizam prema prouzrokovaču lisne rđe. Ustanovljena je viceverza između ekonomičnih i bezbednih tretmana fungicidima s aspekta rezidua. Rešenje koje objedinjuje oba pomenuta faktora je pronađeno u gajenju sorti sa vrednostima ispod 3 i sumom parametara koji utiču na GLAD od najmanje 12.

Ključne reči: *pšenični paraziti, predviđajući model, fungicid, Puccina spp.*

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