Institute of Plant Protection – National Research Institute, Poznań,
Experimental Station in Rzeszów, Poland

PRODUCTIVE AND ECONOMIC EFFICIENCY OF FUNGICIDE TREATMENTS ON SPRING TRITICALE CULTIVATION AND THEIR EFFECT ON GRAIN YIELD AND ECONOMIC RATIOS

Z. Kaniuczak

Abstract

Studies on the economic efficiency of pesticides used on spring triticale were conducted in 2008-2010 in Boguchwała (south-eastern Poland). On average from 52.0 to 86.2% of leaves were infested by triticale diseases. The efficiency of applied fungicides ranged from 44.2 to 87.7%. Yield increase was from 160 to 565 PLN from 1 ha. The cost coverage ratio was from 1.0 to 3.1, and the profitability ratio for treatments was from 2.3 to 7.3. The percentage cost ratio was from 3.5 to 10.4.

Key words: chemical protection, economic ratios, spring triticale

Introduction

The increase in cereal cultivation in Poland observed in recent years favours more extensive infection of these plants by a number of pathogens. Fungi that are able to cause disease in cultivated plants throughout the vegetation season are one of the factors causing a loss in yield volume and quality (Korbas and Kubiak 1998).

Fungal development and infection level may be modified by such factors as the increased share of cereals in the cultivation structure and simplified soil cultivation techniques, as well as changing weather conditions (Parylak 2004, Jaczewska-Kalicka 2008, Pecio and Danyte 2008).

These factors can be controlled by correctly planned crop protection incorporating chemical measures and crop production methods (Skolimowski 1980, Lipa 1999).

Phytopathologia 63: 21–29

ISSN 2081-1756

The profitability of grain production has been relatively low for several years and infrequently brings spectacular profits. High prices of production materials, especially fuel, fertilizers and plant protection means are reasons for which farmers reduce expenses for cultivation of cereals. According to Mierzejewska (1996), in modern agricultural technologies chemical plant protection treatments are a necessary expense as they protect yields.

Infection of cereal plants by various pathogens results in substantial decrease of grain yield and quality. Therefore, studies on control of the diseases and their intensity levels, as well as an ongoing analysis of the achieved economic effects of the performed treatments, are of great importance.

The aim of the study was to evaluate the biological and economic efficiency of fungicides in control of diseases caused by pathogenic fungi in the cultivation of spring triticale in field experiments.

Materials and methods

The study was carried out in 2008-2010 in the cultivation of the spring triticale cv. 'Dublet' in Boguchwała (south-eastern Poland). The experiment was established using the random block method in four replications. The forecrop for spring triticale was winter rape. The triticale was sown on brown soil, class III. Seeds were treated with Funaben T dressing (200 ml per 100 kg of seeds). The following fertilizers were applied: N – 117 kg·ha^{-1}, P_2O_5 – 60 kg·ha^{-1}, K_2O – 90 kg·ha^{-1}. Weed control was performed in 2008 using Lintur 70 WG, dose 75 g·ha^{-1}, and in 2009–2010 using Lintur 70 WG, dose 15 g·ha^{-1} + Chwastox Extra 300 SL, dose 1.0 dm^3·ha^{-1}.

Plots with no antifungal chemical protection were used for control. The intensity of diseases was analysed during the entire vegetation season in compliance with a method described by Lisowicz et al. (1993). Two treatments were applied in order to control diseases:

– I – in spring – at plant growth stage 30–32 BBCH (beginning of stem elongation – node 2) according to Adamczewski and Matysiak (2002): Alert 375 SC (flusilazole 125 + carbendazim 250) – 1.0 dm^3·ha^{-1},

– II – before flowering – at growth stage 51–59 BBCH (beginning of heading – end of heading): Falcon 460 EC (tebuconazole 167 + triadimenol 43 + spiroxamine 250) – 0.6 dm^3·ha^{-1}, and Mirage 450 EC (prochloraz 450) – 1.0 dm^3·ha^{-1}.

The treatments were carried out with a sprayer and 300 dm^3 of liquid per hectare. The infection of triticale by pathogens was evaluated basing on the percentage of the infected surface of the two top leaves: flag leaf and leaf F-1 on 100 stems from each experimental combination. After harvest grain moisture was measured and the obtained grain yield was recalculated for 15% moisture. Significant differences between average results were estimated using the Duncan test at a 5% significance level.

The following ratios were calculated in the economic analysis of disease control profitability: E – cost coverage ratio (specifying the ratio of protected crop yield to

treatment costs), Q_1 – treatment profitability ratio (specifying the number of dt of protected crop to balance the cost of protective treatment), Q_2 – cost ratio (the percentage of yield necessary to balance the treatment cost; Mierzejewska 1985). The above mentioned ratios were calculated basing on average prices for triticale grain, applied plant protection agents and the cost of treatment performance.

Results and discussion

In 2008–2010 weather conditions were variable (Table 1). The most favourable for disease development weather conditions were recorded in 2008. That year, despite of low temperatures and rainfall in spring, further improvement in thermal conditions increased infection of plants by pathogens. During the other two years the level of plant infection by pathogens decreased, mainly due to intense rainfall,

Table 1

Weather conditions in 2008–2010 in Boguchwała

Month	Decade	Average daily air temperature (°C)			Rainfall sum (mm)			Number of days with precipitation		
		2008	2009	2010	2008	2009	2010	2008	2009	2010
April	I	9.81	11.3	7.9	9.5	2.5	13.9	5	1	5
	II	7.97	9.8	8.4	32.1	1.2	34.2	6	2	6
	III	10.0	12.0	10.3	3.9	0.0	0.1	2	0	1
	Mean/sum monthly	9.2	11.0	8.8	45.5	3.7	48.2	4.3	1	4
May	I	11.3	12.6	14.3	30.3	1.6	43.9	7	2	7
	II	14.7	13.5	13.3	45.6	56.0	101.9	6	4	8
	III	14.4	13.7	15.0	29.4	45.0	31.2	3	8	7
	Mean/sum monthly	13.4	13.2	14.2	105.3	102.6	177.0	5.3	4.6	7.3
June	I	17.9	14.9	18.0	1.4	17.8	102.6	1	4	4
	II	16.2	15.5	18.7	40.0	77.9	20.9	3	7	4
	III	19.7	19.3	16.9	45.3	50.7	2.6	6	6	2
	Mean/sum monthly	17.9	16.5	17.8	86.7	146.4	126.1	3.3	5.6	3.3
July	I	17.8	20.0	19.2	35.9	65.4	73.5	6	6	4
	II	19.2	20.1	23.7	43.3	9.0	9.2	6	4	2
	III	19.0	19.8	19.3	38.4	23.6	117.5	6	4	7
	Mean/sum monthly	18.6	19.9	20.7	117.6	98.0	200.2	6	4.6	4.3
August	I	19.6	19.6	20.7	21.2	8.1	4.7	4	2	2
	II	19.9	18.2	20.6	18.2	0.8	33.7	2	1	5
	III	17.3	18.3	17.0	15.9	12.9	60.2	4	4	7
	Mean/sum monthly	18.9	18.7	19.4	55.3	21.8	98.6	3.3	2.3	4.6

and it was particularly clear in 2009. In 2010, very intense rainfall in the study area, especially in May and July, disturbed growth of spring triticale plants, but it had a less significant effect on the infection of plants than in 2009.

Due to weather conditions spring triticale plants became infected by powdery mildew (*Blumeria graminis*), leaf rust (*Puccinia recondita*), leaf and glume blotch (*Septoria nodorum*), tan spot (*Pyrenophora tritici-repentis*), scald (*Rhynchosporium secalis*) and Fusarium head blight (*Fusarium* spp.).

In individual years and in the evaluated combinations the highest percentage of triticale leaves were infected by fungi such as *Septoria nodorum, Blumeria graminis, Puccinia recondita, Pyrenophora tritici-repentis,* and *Fusarium* spp. Other pathogens infected triticale plants with minor or insignificant intensity.

The development of epiphytic leaf tan spot in triticale and wheat cultures in subsequent plant growth stages was studied by Wakuliński et al. (2002). A dynamic development of the disease was recorded by these authors from the shooting stage. A rapid development of epiphytosis was observed in all further plant growth stages. According to Wakuliński et al. (2002), the lowest leaves of triticale were affected to the same degree, while the flag leaf and F-1 and F-2 leaves were affected to much smaller extent (below 50%).

According to Jańczak and Turkiewicz (1992) and Łacicowa et al. (1985), the infection of heads and stem base by *Fusarium* spp. occurs every year in triticale cultivation. Differences in individual vegetation seasons concern only the intensity of the disease.

The harmfulness of *Fusarium* spp. and *Septoria* spp. to triticale is reflected mainly by their negative effect on yield volume and grain quality, which concerns both edible grain and sowing material. According to Zamorski et al. (1993) scald is one of the early occurring triticale diseases. Its intensity is closely associated with changes in weather conditions, and if the conditions are optimum for the pathogen, even the flag leaf may become infected. Scald may lead to preterm dying of all leaves.

Weather conditions also have a strong influence on the occurrence and development of pathogenic fungi. In particular, high precipitation and relative air humidity create favourable conditions for fungal development, which was confirmed by studies carried out by some authors (King et al. 1983, Głazek et al. 2006, Jaczewska-Kalicka 2008).

The results of chemical disease control and its effect on the grain yield of spring triticale are presented in Table 2.

In 2008 the infection level of triticale leaves was very high and reached 86.2%. The applied fungicides (Alert 375 SC and Falcon 460 EC) decreased infection degree, and their efficiency ranged from 51 to 87.7%. The increase in triticale grain yield ranged from 5.1 to 8.7 $dt \cdot ha^{-1}$ (average 11.5%), as compared to control.

In 2009 level of triticale leaves infection was high and reached 58.4%. The applied fungicides (Alert 375 SC and Mirage 450 EC) decreased the leaf infection level, and their efficiency varied from 44.2 to 75.7%. The increase in triticale grain yield ranged from 4.0 to 8.7 $dt \cdot ha^{-1}$ (average 8.7%), as compared to control.

Table 2

The influence of chemical protection on plant infestation and spring triticale grain yield in 2008–2010

No.	Growth stage		Dose of fungicide ($dm^3 \cdot ha^{-1}$)	Infected leaf surface (%)	Effecti-veness (%)	Weight of 1000 cereal grains (g)	Yield ($dt \cdot ha^{-1}$)	Yield increase	
	30–32 BBCH	51–59 BBCH						$dt \cdot ha^{-1}$	%
2008									
1.	Control		–	86.2	–	35.99	62.06	–	–
2.	Alert 375 SC	–	1.0	41.4	51.9	39.58	67.16	5.1	8.2
3.	–	Falcon 460 EC	0.6	13.8	83.9	40.24	70.76	8.7	14.0
4.	Alert 375 SC	Falcon 460 EC	1.0 + 0.6	10.6	87.7	40.66	69.74	7.6	12.3
LSD 0.05			–	4.94	–	2.42	2.13	–	–
2009									
1.	Control		–	58.4	–	36.74	69.84	–	–
2.	Alert 375 SC	–	1.0	32.6	44.2	37.56	73.87	4.0	5.7
3.	–	Mirage 450 EC	1.0	20.4	65.1	37.68	75.24	5.4	7.7
4.	Alert 375 SC	Mirage 450 EC	1.0 + 1.0	14.2	75.7	38.35	78.56	8.7	12.9
LSD 0.05			–	10.23	–	2.08	4.58	–	–
2010									
1.	Control		–	52.0	–	34.76	53.16	–	–
2.	Alert 375 SC	–	1.0	27.7	46.8	35.25	61.64	8.4	15.9
3.	–	Mirage 450 EC	1.0	23.0	55.8	33.95	60.53	7.3	13.8
4.	Alert 375 SC	Mirage 450 EC	1.0 + 1.0	9.6	81.6	36.78	62.61	9.4	17.7
LSD 0.05			–	7.40	–	2.09	5.25	–	–

In 2010 the infection level of triticale leaves was relatively high – on average 52.0%. The applied fungicides decreased the leaf infection level, with an efficiency of 46.8 to 81.6%. The increase in triticale grain yield ranged from 7.3 to 9.4 $dt \cdot ha^{-1}$ (average 15.8%), as compared to control.

Control of fungal diseases determines high wheat yield and improvement of its quality. Three treatments for plant protection against diseases of stem base, leaf and head on the soil of a good wheat complex according to Jończyk (1999) resulted in yield increase by 9.9 $dt \cdot ha^{-1}$, i.e. by 14%. On the rye complex soil the yield in-

crease was lower and accounted for 7.3 dt·ha^{-1} (average 12%). Additionally, chemical protection contributes to effective use of other factors, such as fertilization.

Studies conducted by Podolska and Stypuła (2002) demonstrated that it is possible to achieve grain of the required processing parameters after chemical protection treatments on wheat cultures on farms. Unsuccessful protection contributes to decreased quality parameters of grain.

According to Jańczak and Turkiewicz (1992) the harmful activity of *Fusarium* spp. and *Septoria* spp. which may also occur on triticale leaves, results from the destruction of the assimilative surface of the flag leaf. The control of *Fusarium* diseases in triticale with fungicide spraying during the vegetation period is associated with insufficient efficacy.

Studies carried out by Panasiewicz et al. (2010) on spring triticale demonstrated that increase in nitrogen fertilization also results in increased infection of flag leaves surface by *Puccinia recondita* and increased infection of the head in triticale cultivation by *Cladosporium herbarum*. A similar effect of nitrogen fertilization on spring barley was observed by Panasiewicz et al. (2006).

The economic effects of fungicides used in spring triticale are presented in Table 3.

Table 3

Economic efficiency of fungicide in spring triticale in 2008–2010

No.	Growth stage		Costs of protection per 1 ha (PLN)	Yield increase per 1 ha		Coefficients		
	30–32 BBCH	51–59 BBCH		dt	PLN	E	Q_1	Q_2
2008								
1.	Alert 375 SC	–	154	5.1	331	2.1	2.3	3.5
2.	–	Falcon 460 EC	157	8.7	565	3.1	2.7	3.8
3.	Alert 375 SC	Falcon 460 EC	311	7.6	499	1.4	5.1	7.3
2009								
1.	Alert 375 SC	–	154	4.0	160	1.0	3.8	5.2
2.	–	Mirage 450 EC	138	5.4	216	1.5	3.4	4.5
3.	Alert 375 SC	Mirage 450 EC	292	8.7	348	1.2	7.3	9.2
2010								
1.	Alert 375 SC	–	154	8.4	381	2.4	3.4	5.5
2.	–	Mirage 450 EC	139	7.3	331	2.3	3.0	5.1
3.	Alert 375 SC	Mirage 450 EC	293	9.4	425	1.4	6.5	10.4

E – cost coverage ratio, Q_1 – treatment profitability index, Q_2 – percentage index of the costs.

In 2008 triticale protection resulted in the yield increase from 331 to 565 PLN per 1 ha, on average 465 PLN per 1 ha. The most favourable cost coverage ratio was recorded for the plot protected with the fungicide Falcon 460 EC (3.1). The average profitability ratio for treatments was 3.3, and the percentage cost ratio was 4.6.

In 2009 the productive efficiency of chemical protection achieved in individual triticale plots expressed as the value of protected yield ranged from 160 to 348 PLN

per 1 ha (average 241 PLN per 1 ha). The cost coverage ratio was from 1.0 to 1.5. The treatment profitability ratio was from 3.4 to 7.3 respectively, and the percentage cost ratio was from 4.5 to 9.2.

In 2010 for spring triticale the most favourable cost coverage ratio was recorded in the plot sprayed with Alert 375 SC at dose 1.0 $dm^3 \cdot ha^{-1}$ (2.4). The average treatment profitability ratio was 4.3, and the percentage cost ratio was 7.0.

An increase in the value of the protected yield of spring triticale grain was achieved during the study period, but it was not sufficient to cover the protection costs and ensure profit every year. In 2009 the calculated cost coverage ratio for plots 1 and 3 attained a relatively low value, close to one. On the other hand, high ratios of treatment profitability on these plots signal an increasingly unfavourable relationship between the protection costs (high price of fungicides) and the sale price for triticale grain, which was confirmed in previous studies by some authors (Juszczak and Krasiński 1998, Kaniuczak 2000, Jaczewska-Kalicka 2001, Kaniuczak and Bereś 2008).

Studies conducted by Golinowska (2001) and Jaczewska-Kalicka (2008), demonstrated high yield increase achieved as a result of disease control in wheat, which were sufficient to cover treatment costs and maintain a relatively high profit. According to these authors pathogen monitoring with modern diagnostic methods, and modern techniques in cereal protection will result in higher yields and better economic outcomes.

Studies conducted by various authors (Jończyk 1999, Korbas 2002, Podolska and Stypuła 2002, Kurowski and Hruszka 2004, Kaniuczak 2005, Kaniuczak and Bereś 2008) demonstrated that appropriate protection of cereals, appropriately chosen treatment date and efficient fungicides ensure a substantial yield increase and improvement of grain parameters.

Conclusions

1. In south-eastern Poland cultures of spring triticale are destroyed by many agrophages, and factors causing diseases play an important role among them. In the study years pathogens posed a high threat to cereal plants, infecting from 52.0% to 86.2% of the spring triticale leaf surface.

2. Under weather conditions favourable to pathogen development the applied fungicides demonstrated good efficiency, amounting from 44.2 to 87.7%.

3. Fungicides substantially reduce the surface of leaves destroyed by fungal diseases. Chemical treatments carried out to control pathogens resulted in the increase of triticale grain yield from 4.0 to 9.4 $dt \cdot ha^{-1}$ (on average by 7.1 $dt \cdot ha^{-1}$).

4. Considering the current relation between fungicide prices and triticale grain prices chemical treatments demonstrated profitability in all experimental combinations.

Streszczenie

EFEKTYWNOŚĆ PRODUKCYJNA I EKONOMICZNA ZABIEGÓW FUNGICYDOWYCH W UPRAWIE PSZENŻYTA JAREGO I ICH WPŁYW NA PLON ZIARNA ORAZ WSKAŹNIKI EKONOMICZNE

Badania ekonomicznej efektywności fungicydów zastosowanych do ochrony pszenżyta jarego w latach 2008–2010 wykonano w Boguchwale (południowo-wschodnia Polska). Średnie porażenie powierzchni liści przez choroby pszenżyta wyniosło od 52,0 do 86,2%. Skuteczność zastosowanych fungicydów wyniosła od 44,2 do 87,7%. Nadwyżka wartości produkcji mieściła się w granicach od 160 do 565 zł na hektar. Wskaźnik pokrycia kosztów wyniósł od 1,0 do 3,1, a wskaźnik opłacalności zabiegów – od 2,3 do 7,3. Procentowy wskaźnik kosztów zawierał się w przedziale od 3,5 do 10,4.

Literature

Adamczewski K., Matysiak K., 2002: Zboża. In: Klucz do określania faz rozwojowych roślin jedno- i dwuliściennych w skali BBCH. [H. Bleiholder et al.: Compendium of growth stage identification key for mono- and dicotyledonous plants]. Translation and adaptation: K. Adamczewski, K. Matysiak. IOR, Poznań: 15–19.

Głazek M., Krzyzińska B., Mączyńska A., Bałachowska J., 2006: Zmiany w zagrożeniach uprawy pszenicy ozimej przez choroby grzybowe na przestrzeni lat 1995–2005 w rejonie Polski południowo-środkowej. Prog. Plant Prot. / Post. Ochr. Rośl. 46, 1: 347–353.

Golinowska M., 2001: Metody badawcze oceny ekonomicznej efektywności zabiegów ochrony roślin. Prog. Plant Prot. / Post. Ochr. Rośl. 41, 1: 215–222.

Jaczewska-Kalicka A., 2001: Występowanie chorób i straty plonu pszenicy ozimej ze szczególnym uwzględnieniem wpływu warunków klimatycznych. Prog. Plant Prot. / Post. Ochr. Rośl. 41, 1: 607–610.

Jaczewska-Kalicka A., 2008: Wpływ zmiennych warunków klimatycznych na występowanie i szkodliwość grzybów patogenicznych w uprawie pszenicy ozimej. Zesz. Probl. Post. Nauk Roln. 531: 63–69.

Jańczak C., Turkiewicz A., 1992: Choroby pszenżyta i ich zwalczanie w okresie wegetacji. Mater. 32. Ses. Nauk. Inst. Ochr. Rośl. cz. I – Referaty: 43–52.

Jończyk K., 1999: Efektywność chemicznego zwalczania chorób grzybowych w uprawie pszenicy ozimej i żyta. Pam. Puław. 114: 151–158.

Juszczak M., Krasiński T., 1998: Ekonomiczna ocena ochrony pszenicy ozimej i rzepaku ozimego. Prog. Plant Prot. / Post. Ochr. Rośl. 38, 1: 247–257.

Kaniuczak Z., 2000: Ocena ekonomicznej efektywności stosowania fungicydów w zbożach. Rocz. AR Pozn. 321, Ogrodn. 30: 49–54.

Kaniuczak Z., 2005: Wpływ chemicznej ochrony pszenżyta ozimego i pszenicy jarej przed chorobami na plon ziarna i wskaźniki ekonomiczne. Rocz. AR Pozn. 374, Roln. 64: 45–53.

Kaniuczak Z., Bereś P., 2008: Efektywność ekonomiczna zastosowanych fungicydów w ochronie pszenżyta ozimego i pszenicy ozimej przed chorobami grzybowymi. Zesz. Probl. Post. Nauk Roln. 531: 71–79.

King J.E., Cook R.J., Melville S.C., 1983: A review of septoria diseases of wheat and barley. Ann. Appl. Biol. 103: 345–373.

Korbas M., 2002: Kompleksowa ochrona zbóż przed chorobami grzybowymi. In: Produkcja i rynek zbóż. Ed. J. Rozbicki. Wieś Jutra, Warszawa: 223–237.

Korbas M., Kubiak K., 1998: Chemiczna ochrona jęczmienia jarego i pszenicy ozimej a niektóre cechy plonu ziarna wpływające na jego jakość. Prog. Plant Prot. / Post. Ochr. Rośl. 38, 2: 473–476.
Kurowski T.P., Hruszka M., 2004: Zdrowotność i plonowanie pszenżyta ozimego w łanie chronionym zabiegami chemicznymi i proekologicznymi. Prog. Plant Prot. / Post. Ochr. Rośl. 44, 2: 896–899.
Lipa J.J., 1999: Nowoczesna ochrona zbóż. Pam. Puław. 114: 241–259.
Lisowicz F., Kaniuczak Z., Śnieżek G., 1993: Metody sygnalizacji i progi zwalczania najważniejszych chorób i szkodników zbóż. ODR, Boguchwała.
Łacicowa B., Kiecana I., Wagner A., 1985: Badania nad grzybami z rodzaju *Fusarium* występującymi na pszenżycie. Rocz. Nauk Roln. Ser. E 15, 1/2: 51–65.
Mierzejewska W., 1985: Metody badawcze i miary oceny ekonomicznej efektywności chemicznych zabiegów ochrony roślin. Post. Nauk Roln. 32/37, 5: 77–90.
Mierzejewska W., 1996: Ochrona roślin w Polsce w początkowym okresie wprowadzania gospodarki rynkowej. Zesz. Nauk. AR Wroc. 290, Roln. 46: 9–34.
Panasiewicz K., Koziara W., Sulewska A., 2006: Występowanie chorób grzybowych na jęczmieniu jarym w zależności od wybranych czynników agrotechnicznych. Prog. Plant Prot. / Post. Ochr. Rośl. 46, 1: 684–687.
Panasiewicz K., Koziara W., Sulewska A., Szymańska G., 2010: Ocena porażenia pszenżyta jarego przez grzyby w zależności od deszczowania, sposobu uprawy roli i nawożenia azotem. Prog. Plant Prot. / Post. Ochr. Rośl. 50, 2: 944–948.
Parylak D., 2004: Possibilities of root and stem base diseases limitation in continuous wheat dander conventional tillage and no-tillage system. J. Plant Prot. Res. 44, 2: 141–146.
Pecio A., Danyte V., 2008: Wpływ warunków pogody na porażenie zbóż jarych patogenami liści i kłosów. Prog. Plant Prot. / Post. Ochr. Rośl. 48, 2: 499–503.
Podolska G., Stypuła G., 2002: Plonowanie i wartość technologiczna ziarna pszenicy ozimej w zależności od sposobu ochrony przed chorobami i chwastami. Pam. Puław. 130: 587–596.
Skolimowski A.W., 1980: Zwalczanie chorób pszenicy ozimej i jęczmienia jarego. Ochr. Rośl. 9: 4–5.
Wakuliński W., Zamorski Cz., Nowicki B., Schollenberger M., Kachlicki P., 2002: Wybrane zagadnienia z epidemiologii brunatnej plamistości liści pszenicy i pszenżyta – charakterystyka i znaczenie źródeł infekcji pierwotnej. Acta Agrobot. 55, 1: 347–357.
Zamorski Cz., Schollenberger M., Sieklucka M., 1993: Zróżnicowanie podatności genotypów pszenżyta na rdzę brunatną i rynchosporiozę. In: Materiały z Sympozjum: Biotyczne środowisko uprawne a zagrożenie chorobowe roślin. Olsztyn, 7–9 września 1993. PTFit, AR-T w Olsztynie, Olsztyn: 435–441.

Author's address:
Dr. Zdzisław Kaniuczak, Institute of Plant Protection – National Research Institute, Experimental Station in Rzeszów, ul. Langiewicza 28, 35-101 Rzeszów, Poland, e-mail: z.kaniuczak@iorpib.poznan.pl

Accepted for publication: 4.05.2012