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APPLICATION OF REDUCED DOSES OF TRIAZOLES FOR THE CONTROL OF WINTER WHEAT LEAF DISEASES

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Summary

The efficacy of reduced doses of six triazole fungicides on winter wheat cv. Zentos was estimated over the period 1999-2000. The spread of powdery mildew *(Blumeria graminis* (DC) Spear.) in winter wheat in 1999 at the early milk stage was intensive, but in 2000 at water ripe the disease occurrence was weak. The full and reduced to ½ and ¾ doses of triazoles provided a good control against mildew, especially on flag leaf of winter wheat. Septoria leaf blotch (*Septoria* spp.) and tan spot *(Pyrenophora tritici repentis* (Died.) Drechs.) occurred on winter wheat annually. Against Septoria leaf blotch full and reduced dosages of triazoles were highly effective till the early milk stage, especially on a flag leaf. At late milk the efficacy of reduced doses of the fungicides was lower than that of full doses. Against tan spot the full doses of fungicides provided a good control, however, the efficacy of reduced doses was low. Full and reduced doses of fungicides provided excellent control of brown rust *(Puccinia recondita).*

Due to the full and ¾ reduced dosages of the fungicides a sufficient yield increase was obtained annually. The yield increase through reduced to ½ dose was low and insufficient. The yield increase was obtained due to an increase in 1000 grain weight.

Key words: winter wheat, triazole fungicide, doses, leaf diseases, grain yield

Introduction

In order to minimise disease – induced yield loss, it is necessary to protect the flag leaf and leaf 2 until the end of grain filling /Jordan, Hutsheon, 1994/. To provide acceptable control against the foliar diseases of winter wheat until the end of grain filling without increasing the risk of yield losses, reduced fungicide inputs need to be investigated.

In Lithuania wheat powdery mildew caused by the obligate pathogen *Blumeria graminis* (DC) Speer f. sp. *tritici* is a common disease which in some years can be economically important. Early spread of powdery mildew can be extremely harmful. The disease severity covering 25 % of leaf surface at stem elongation stage can reduce the grain yield by 30 %, but the same disease severity at heading reduced the yield by only 8 % /Terechov et al., 1995/. One of the main problems in chemical control of wheat powdery mildew is development of resistance in the target organism. The split application with fenpropimorph containing fungicides can decrease the rate of sensitivity of population of *B. graminis* /Engels, 1996/.

The initial infection of brown rust (*Puccinia recondita* f. sp. *tritici* Rob.ex Desm.) in winter wheat stands can occur as a result of autumn infection that survived the winter in the field and through uredospores carried by the wind from the infected fields. In years with no *P. recondita* survival on wheat the yield losses due to the disease were less than 2 %, whereas the losses were greater than 2 % in years when the fungus did survive the winter.

This was due to maximum severities being reached up to two weeks earlier in plots where survival occurred /Eversmeyer et al., 1988/. Latent and infectious periods of *P. recondita* were lower on seedlings and flag leaves at higher than at lower temperatures and latent and infectious periods were shorter on seedlings than on adult plants /Tomerlin et al., 1983/. According to the model based on light interception, photosynthesis, respiration and assimilate portioning, 66 % of the total yield reduction was due to an accelerated decrease in green leaf area and 18% was due to light capture by dead leaf tissue at the top of the canopy. Leaf rust did not affect the photosynthetic rate of the remaining green leaf area /Van Roermund, Spitters, 1990/.

The two major pathogens comprising the Septoria disease complex on wheat are *Septoria tritici* (Rob.) Desm., causing Septoria leaf blotch or speckled leaf blotch, and *Stagonospora nodorum* (Berk.) Cast. (syn. *Septoria nodorum* (Berk.), causing Septoria leaf and glume blotch. Both pathogens are economically important worldwide /Cunfer, Ueng, 1999/. The level of leaf blotch caused by *S. tritici* was influenced by a lower temperature, but growth stage had no effect on the disease severity. *S. nodorum* caused high levels of leaf and glume blotch at higher temperatures and was more pathogenic at late growth stages. The cooler temperatures of spring favour development of leaf blotch caused by *S. tritici*, but the greater prevalence of *S. nodorum* later in the season may be a consequence of increasing susceptibility of wheat plants to pathogen /Shaner, Beuchley, 1995; Wainshilbaum, Lipps, 1991/. The epiphytotic incidence of Septoria leaf blotch in winter wheat canopy has been determined by the amount of rainfall, number of rainy days, previous crop, straw residue on soil surface and other factors /Hansen et al., 1994/. Gradual epidemics of Septoria leaf blotch were characterized by disease arising on successive leaf layers as they appeared during sustain periods of weather suitable for inoculum's transport and infection. Sudden outbreaks of infection can be due to short, heavy rainstorms in which pycnidiospore inoculum in basal leaves were evaluated up to 60 cm through the crop canopy /Royle et al., 1986/. The optimum regeneration time for *S. tritici* in field crops is 21 days, but for *S. nodorum* it takes only 7-15 days /Shaner, Beuchley, 1995/.

Tan spot (*Drechslera tritici-repentis* (Died.) Shoem.) has recently become recognised as one of the important and widespread diseases of wheat. Losses due to tan spot have been chronically 3-15% and as high as 50% of grain yield /Hosford et al., 1987/. Development of pseudothecia *D. tritici-repentis* on wheat stubble residues exhibited a seasonal pattern in which the ascocarps enlarged during August-October, asci formed during December-March, and ascospores differentiated beginning in late February or March. Mature pseudothecia capable to release ascospores were found from early April to mid June. Conidia of the pathogen dispersed from diseased wheat leaves were trapped chiefly in June and July. Circumstantial evidence indicated that ascospores infected mainly the lower leaves (leaf 3 and below) and conidia infected the upper leaves /Wright, Sutton, 1990/.

The level of attack of leaf diseases of winter wheat at the time of application and also the level of epidemic disease development after treatment has a considerable influence on the duration of effect of different rates of fungicides. Full doses generally lasted for 40-45 days. Half rate lasted for approximately 35-45 days and only 25 days in a severe attack. Quarter dose lasted for approximately 25-30 days and only 0-15 days in severe attack /Jorgensen, 1994/.

Materials and Methods

The trials were conducted during 1999-2000 at the Lithuanian Institute of Agriculture in Dotnuva. The winter wheat variety 'Zentos' was sown at a rate of 4.5 million seed per ha with 12 cm row spacings. The trials were arranged in 10 m long and 2.5 m wide

plots with four replicates. The registered rates of fungicides (a.i.) were referred to as full dose. The fungicides were applied in 1999 at the end of booting stage (BBCH 47) and in 2000 at the beginning of heading (BBCH 53). Disease assessments were conducted twice - at early and at late milk ripe stages. Plant growth stages were identified according to the BBCH scale (1997). The leaf positions on tillers are numbered relative to the uppermost leaf the flag leaf F, the leaf immediately below the flag leaf - F-1, and the leaf below F-1 – F-2. Percent of leaf area showing symptoms of leaf diseases was used to quantify disease severity. Disease severity was assessed on each plot in five randomly selected places on three adjacent tillers F, F-1, F-2 leaves using a percentage scale 0, 1, 5, 10, 25, 50, 75. Percent of affected leaves was used to quantify the disease incidence. The plots were harvested and yields in t ha^{-1} were adjusted to 15% moisture content. The significance of data was determined by the F-test with a significance level of $P \leq 0.05$.

Results and Discussion

The average from flag leaf fully emerged (BBCH 39) to anthesis equates to 16 days and the period from anthesis until the end of grain filling equates to 45 days /Porter et al., 1987/. This indicates that a 60-day period of disease protection is required from flag leaf fully emerged until the end of grain filling. The cost effective disease control responses from fungicide dose reduction.

An early and warm spring in 1999 stipulated early appearance of powdery mildew in winter wheat stands. Later dry weather conditions slowed down the disease outspread. At end of booting before application all stems of winter wheat variety Zentos had symptoms of mildew. Initial spots were observed on 30 % of flag leaves and 55 % of F-1. On F-2 leaves the incidence of mildew covered 80 %, the disease severity was 1.60 %. Due to hot weather conditions the development of plants was very fast and after two weeks winter wheat reached early milk stage. The incidence of mildew in untreated plots at early milk (BBCH 73) was 37.8-58.7 % on flag leaves, 77.8-88.9 % on F-1 and 78.8-90.4 % on F-2, the severity of the disease was 0.53-0.73 %, 1.60-2.43 % and 2.27-3.10, respectively (Table 1). Full and reduced doses of the tested triazole fungicides highly suppressed the incidence and severity of powdery mildew on flag leaves and the disease severity on F-1 and F-2 leaves. The incidence and severity of the disease on F-1 and F-2 in applied plots with half dose of fungicides was higher, and on F-2 leaves insignificant. The disease severity in the plots applied with reduced doses was higher, but the difference from untreated plot was significant.

The spring in 2000 was early and unusually warm. In early spring the spread of powdery mildew was intensive, but after more than a month without any precipitation the spread of the disease was suppressed. At the beginning of heading (BBCH 73) the incidence of mildew was on solitary flag leaves, on 24 % F-1 and on 36% F-2 leaves, the disease severity was 0.04 %, 0.24 % and 0.52 %, respectively. Cool and rainy weather in June was unfavourable for the spread of mildew. Three weeks after fungicide application at the water ripe stage (BBCH 71) the incidence of powdery mildew was 5.0-18.4 % on flag leaves, 35.0-53.3 % on F-1 and 43.3-70.0 % on F-2, the severity of the disease was 0.05-0.18 %, 0.35-0.67 % and 0.50-1.04 %, respectively (Table 2). The efficacy of fungicides against mildew was low, especially on F-2 leaves. A trend was revealed that the efficacy of fungicides was higher in the treatments where the disease incidence and severity were higher in control plots. The efficacy of full doses of fungicides was higher than that of reduced doses. Although the most effective fungicides against powdery mildew were fenpropidin and fenpropimorph, but there is evidence to suggest that their associated yields did not differ from triazole fungicides /Hardwick et al., 1994/

Table 1. Incidence and severity of powdery mildew in winter wheat in relation to reduced dosage of fungicides at early milk stage (BBCH 73)

1 lentelė. *Miltligės išplitimas ir intensyvumas žieminiuose kviečiuose ankstyvos pieninės brandos tarpsniu, panaudojus sumažintas fungicidų normas*

Dotnuva, 1999

Treatment *Variantas*	F			F-1			F-2		
	1/1	¾	½	1/1	¾	½	1/1	¾	½
Incidence % / *Išplitimas %*									
Untreated / *Nepurkšta*	58,7	42,2	37,8	88,9	77,8	88,9	80,6	90,4	78,8
Cyrpoconazole 80 g ha^{-1}	4.5	6.7	17.8	53.3	51.1	64.4	60.6	48.8	62.0
Tebuconazole 250 g ha^{-1}	4.5	0	2.2	46.6	57.8	55.6	55.6	57.0	53.6
Propiconazole 125 g ha^{-1}	4.5	15.6	8.9	44.4	57.8	66.7	46.7	66.3	77.0
Flutriafol 125 g ha^{-1}	0	8.9	6.7	44.4	68.9	71.1	64.3	66.2	60.1
Fluqvinconazole 125 g ha^{-1}	4.5	2.2	11.1	31.1	31.1	51.1	64.8	47.6	60.5
Metconazole 90 g ha^{-1}	2.2	11.1	8.9	55.6	55.6	62.2	48.7	61.6	67.0
LSD $_{05}$ / R_{05}	9.05	16.03	17.42	28.37	25.02	22.05	27.26	19.74	25.37
Severity % / *Intensyvumas %*									
Untreated / *Nepurkšta*	0.63	0.53	0.73	1.77	1.60	2.43	2.27	2.90	3.10
Cyrpoconazole 80 g ha^{-1}	0.05	0.06	0.16	0.63	0.50	1.07	0.77	0.63	1.10
Tebuconazole 250 g ha^{-1}	0.05	0	0.02	0.63	0.67	0.73	1.03	0.67	0.70
Propiconazole 125 g ha^{-1}	0.05	0.16	0.08	0.43	0.67	0.97	0.67	1.33	1.27
Flutriafol 125 g ha^{-1}	0	0.06	0.07	0.87	1.20	1.10	1.27	1.45	1.70
Fluqvinconazole 125 g ha^{-1}	0.05	0.02	0.12	0.50	0.33	0.97	1.10	0.73	1.47
Metconazole 90 g ha^{-1}	0.02	0.11	0.09	0.67	0.57	1.17	0.97	1.17	1.13
LSD $_{05}$/ R_{05}	0.080	0.125	0.341	0.620	0.656	0.655	1.038	1.009	1.001

Table 2. Incidence and severity of powdery mildew in winter wheat in relation to reduced dosage of fungicides at water ripe stage (BBCH 71)

2 lentelė. *Miltligės išplitimas ir intensyvumas žieminiuose kviečiuose grūdo formavimosi pradžioje, panaudojus sumažintas fungicidų normas*

Dotnuva, 1999

Treatment *Variantas*	F			F-1			F-2		
	1/1	¾	½	1/1	¾	½	1/1	¾	½
Incidence % / *Išplitimas %*									
Untreated / *Nepurkšta*	11.7	5.0	18.4	35.0	50.0	53.3	43.3	55.0	70.0
Cyrpoconazole 80 g ha^{-1}	3.3	5.0	3.3	35.0	53.3	38.4	45.0	61.6	61.7
Tebuconazole 250 g ha^{-1}	0	0	0	23.4	25.0	26.7	35.0	58.4	51.7
Propiconazole 125 g ha^{-1}	3.4	1.7	5.0	26.7	23.3	36.7	43.3	40.0	58.4
Flutriafol 125 g ha^{-1}	3.4	5.0	3.3	35.0	31.7	55.0	55.0	45.0	65.0
Fluqvinconazole 125 g ha^{-1}	1.7	1.7	1.7	13.3	25.0	33.3	31.7	36.7	41.6
Metconazole 90 g ha^{-1}	0	1.7	1.7	10.0	20.0	31.7	35.0	45.0	46.7
LSD $_{05}$ / R_{05}	6.32	5.67	8.09	18.57	21.93	26.03	21.93	21.40	20.43
Severity % / *Intensyvumas %*									
Untreated / *Nepurkšta*	0.12	0.05	0.18	0.35	0.50	0.67	0.50	0.62	1.04
Cyrpoconazole 80 g ha^{-1}	0.03	0.05	0.03	0.35	0.53	0.38	0.52	0.62	0.62
Tebuconazole 250 g ha^{-1}	0.02	0	0	0.24	0.25	0.27	0.35	0.58	0.58
Propiconazole 125 g ha^{-1}	0.02	0.02	0.05	0.27	0.23	0.44	0.50	0.40	0.72
Flutriafol 125 g ha^{-1}	0.04	0.05	0.03	0.35	0.32	0.62	0.62	0.52	0.86
Fluqvinconazole 125 g ha^{-1}	0.02	0.02	0.02	0.13	0.25	0.33	0.32	0.37	0.48
Metconazole 90 g ha^{-1}	0	0.02	0.02	0.10	0.20	0.38	0.35	0.52	0.53
LSD $_{05}$ / R_{05}	0.063	0.570	0.081	0.185	0.220	0.324	0.263	0.305	0.379

The dry spring of 1999 was unfavourable for the incidence of Septoria leaf blotch. At the time of fungicide application (BBCH 47) Septoria had affected 25% F-2 leaves, the disease severity was as low as 0.4 %. Two weeks after application, at winter wheat early milk stage (BBCH 73) Septoria leaf blotch affected 15.6-26.7% F and 55.6-82.2% F-1 and 97.8-100 % F-2 leaves, but the severity of the disease was as low as 0.17-0.33% of F and 1.63-1.83% of F-1 and 4.0-6.13 % F-2 leaf surface (Table 3). Full and reduced doses of fungicides effectively suppressed the incidence and severity of Septoria on flag, F-1 and F-2 leaves till early milk stage. Late in the season rain and cooler weather resulted in heavy incidence of Septoria. At the end of milk stage, 5 weeks after application almost all flag leaves in the untreated plots were affected (Table 4). Only a full rate of Tebuconazole and Metconazole highly suppressed the incidence of Septoria. The incidence and severity of Septoria were higher in the treatments with reduced doses of fungicides. At high infection level at late milk the full and the reduced doses of Cyproconazole, Flutriafol and Fluqvinconazole did not affect the incidence and reduced doses provided only a slight effect on the severity of Septoria leaf blotch.

Table 3. Incidence and severity of brown rust in winter wheat in relation to reduced dosage of fungicides at early (BBCH 73) and late milk stage (BBCH 79)
3 lentelė. *Rudųjų rūdžių išplitimas ir intensyvumas žieminiuose kviečiuose ankstyvos ir vėlyvos pieninės brandos metu, panaudojus sumažintas fungicidų normas*
Dotnuva, 1999

Treatment *Variantas*	BBCH 73			BBCH 79		
	F - F-2			F		
	1/1	¾	½	1/1	¾	½
Incidence % / *Išplitimas %*						
Untreated / *Nepurkšta*	10.6	3.1	6.2	44.5	40.0	31.1
Cyrpoconazole 80 g ha^{-1}	0	0	0	4.5	8.9	6.7
Tebuconazole 250 g ha^{-1}	0	0	0	0	0	2.2
Propiconazole 125 g ha^{-1}	2.2	0	0	2.2	31.1	20.0
Flutriafol 125 g ha^{-1}	2.3	0.8	2.3	8.9	26.7	40.0
Fluqvinconazole 125 g ha^{-1}	0	0	0	0	4.5	2.2
Metconazole 90 g ha^{-1}	0	0	0	0	6.7	2.2
LSD $_{05}$ / R_{05}	3.65	0.93	0.207	10.98	17.64	19.97
Severity % / *Intensyvumas %*						
Untreated / *Nepurkšta*	0.11	0.03	0.06	0.73	0.67	0.31
Cyrpoconazole 80 g ha^{-1}	0	0	0	0.05	0.18	0.07
Tebuconazole 250 g ha^{-1}	0	0	0	0	0	0.02
Propiconazole 125 g ha^{-1}	0.02	0	0	0.02	0.31	0.20
Flutriafol 125 g ha^{-1}	0.02	0.01	0.02	0.29	0.27	0.69
Fluqvinconazole 125 g ha^{-1}	0	0	0	0	0.05	0.02
Metconazole 90 g ha^{-1}	0	0	0	0	0.07	0.02
LSD $_{05}$ / R_{05}	0.042	0.009	0.014	0.244	0.299	0.384

Table 4. Incidence and severity of brown rust in winter wheat in relation to reduced dosage of fungicides at water ripe (BBCH 71) and late milk stage (BBCH 77)
4 lentelė. *Rudųjų rūdžių išplitimas ir intensyvumas žieminiuose kviečiuose grūdo formavimosi tarpsniu, panaudojus sumažintas fungicidų normas*

Dotnuva, 2000

Treatment *Variantas*	BBCH 71			BBCH 77		
	F - F-2			F		
	1/1	¾	½	1/1	¾	½
	Incidence % / *Išplitimas %*					
Untreated / *Nepurkšta*	45.0	37.2	50.5	81.2	68.6	76.9
Cyrpoconazole 80 g ha^{-1}	0.6	0.6	3.9	2.9	19.7	27.4
Tebuconazole 250 g ha^{-1}	0	0	2.8	2.9	3.7	19.9
Propiconazole 125 g ha^{-1}	1.1	5.0	8.9	58.1	53.2	75.9
Flutriafol 125 g ha^{-1}	1.1	16.1	23.9	35.0	77.9	63.0
Fluqvinconazole 125 g ha^{-1}	0	0	4.4	8.7	13.7	24.7
Metconazole 90 g ha^{-1}	0	0	1.6	2.5	4.5	20.4
LSD $_{05}$ / R_{05}	9.32	7.04	13.14	17.63	23.97	28.03
	Severity % / *Intensyvumas %*					
Untreated / *Nepurkšta*	0.73	0.57	1.00	3.38	3.83	4.37
Cyrpoconazole 80 g ha^{-1}	0.01	0.01	0.04	0.09	0.34	0.81
Tebuconazole 250 g ha^{-1}	0	0	0.03	0.03	0.03	0.34
Propiconazole 125 g ha^{-1}	0.01	0.05	0.16	0.85	1.52	2.24
Flutriafol 125 g ha^{-1}	0.01	0.20	0.44	0.97	2.44	1.48
Fluqvinconazole 125 g ha^{-1}	0	0	0.04	0.09	0.27	0.45
Metconazole 90 g ha^{-1}	0	0	0.02	0.02	0.11	0.24
LSD $_{05}$ / R_{05}	0.189	0.094	0.252	0.419	1.06	1.485

In 2000 due to the drought in spring Septoria leaf blotch appeared in winter wheat late. At the time of application (BBCH 53) only initial symptoms of Septoria appeared on F-2 leaves. Three weeks after the application, at water ripe the incidence of Septoria was weaker than that in 1999. Due to favourable weather conditions a sudden outbreak of infection occurred at late milk. At water ripe all rates of fungicides provided a good control of Septoria (Table 5), but at late milk 5 weeks after application, only full doses of Tebuconazole and Metconazole suppressed the incidence of the disease (Table 6). At late milk the severity of Septoria was higher in the treatments with reduced doses. The efficacy against the disease of the full and reduced doses of Cyproconazole and Fluqvinconazole, and reduced doses of Flutriafol was weaker.

In 1999 tan spot in the winter wheat stands appeared at the end of heading – flowering stage. At early milk in the untreated plots tan spot infection was found on 60-80 % flag leaves, 53.1-73.3 % F-1 and 34.8-54.3 % F-2 leaves. But the severity of the disease was low and covered as little as 0.4-0.93 % of leaf surface (Table 7). The higher infection level on flag and F-2 leaves than on F-2 shows that *D. tritici-repentis* infection was airborne. Airborne conidia could have travelled on the order to ten kilometres. Over wintered wheat residues advanced higher tan spot severity before anthesis, but the residues did not affect late-season disease severity. Therefore, inter-field dispersal of viable conidia *D. tritici-repentis* should be weighed as a factor in tan spot epidemics wherever wheat is grown intensively /Francl, 1997/.Two weeks after application of full doses the tested triazoles sufficiently reduced the incidence and severity of tan spot infection on flag and on F-1 leaves. The efficacy of reduced doses of most fungicides was insufficient except for

Tebuconazole and Metconazole. 5 weeks after application the incidence of tan spot became sever and in untreated plots almost all upper leaves were injured, the severity of the disease on flag leaves increased up to 2.15-3.04 % leaf surface (Table 8). The tested triazoles slightly decreased the incidence, but effectively inhibited the disease severity except for reduced doses of Cyproconazole and Fluqvinconazole.

Table 5. Incidence and severity of Septoria leaf blotch in winter wheat in relation to reduced dosage of fungicides at early milk stage (BBCH 73)
5 lentelė. *Septoriozės išplitimas ir intensyvumas žieminiuose kviečiuose pieninės brandos pradžios tarpsniu, panaudojus sumažintas fungicidų normas*
Dotnuva, 1999

Treatment *Variantas*	F			F-1			F-2		
	1/1	¾	½	1/1	¾	½	1/1	¾	½
	Incidence % / *Išplitimas %*								
Untreated / *Nepurkšta*	20.0	15.6	26.7	80.0	55.6	82.2	97.8	97.8	100
Cyrpoconazole 80 g ha^{-1}	2.2	6.7	6.7	22.2	37.8	37.8	74.1	66.1	79.2
Tebuconazole 250 g ha^{-1}	0	4.5	0	6.7	8.9	22.2	43.2	45.4	47.2
Propiconazole 125 g ha^{-1}	0	0	0	4.5	8.9	6.7	31.2	50.8	55.2
Flutriafol 125 g ha^{-1}	4.5	2.2	2.2	26.7	35.6	31.1	57.1	82.4	68.6
Fluqvinconazole 125 g ha^{-1}	2.2	2.2	4.4	37.8	42.2	37.8	65.3	83.8	64.6
Metconazole 90 g ha^{-1}	2.2	2.2	2.2	6.7	20.0	28.9	40.8	61.4	48.5
LSD $_{05}$ / R_{05}	6.02	9.09	14.42	19.91	25.82	19.85	25.49	21.37	28.89
	Severity % / *Intensyvumas %*								
Untreated / *Nepurkšta*	0.30	0.17	0.33	1.63	1.83	1.93	4.00	4.20	6.13
Cyrpoconazole 80 g ha^{-1}	0.02	0.06	0.06	0.30	0.57	0.47	1.53	0.97	2.00
Tebuconazole 250 g ha^{-1}	0	0.05	0	0.06	0.10	0.30	0.43	0.67	0.73
Propiconazole 125 g ha^{-1}	0	0	0	0.05	0.09	0.06	0.50	0.93	0.57
Flutriafol 125 g ha^{-1}	0.05	0.02	0.02	0.26	0.43	0.30	0.57	1.50	0.80
Fluqvinconazole 125 g ha^{-1}	0.02	0.02	0.03	0.63	0.60	0.56	0.87	1.57	1.60
Metconazole 90 g ha^{-1}	0.02	0.02	0.02	0.06	0.19	0.27	0.43	1.27	1.06
LSD $_{05}$ / R_{05}	0.118	0.096	0.193	0.295	0.899	0.451	0.628	0.751	1.497

Table 6. Incidence and severity of Septoria leaf blotch in winter wheat in relation to reduced dosage of fungicides at late milk stage (BBCH 79)
6 lentelė. *Septoriozės išplitimas ir intensyvumas žieminiuose kviečiuose pieninės brandos pabaigos tarpsniu, panaudojus sumažintas fungicidų normas*
Dotnuva, 1999

Treatment *Variantas*	BBCH 79					
	Incidence % / *Išplitimas %*			Severity % / *Intensyvumas %*		
	1/1	¾	½	1/1	¾	½
Untreated / *Nepurkšta*	97.8	100	100	19.00	12.51	20.40
Cyrpoconazole 80 g ha^{-1}	100	100	100	5.51	11.27	13.00
Tebuconazole 250 g ha^{-1}	40.0	82.2	86.7	0.76	1.53	3.73
Propiconazole 125 g ha^{-1}	77.8	97.8	86.7	1.52	4.09	4.93
Flutriafol 125 g ha^{-1}	88.9	100	100	4.73	8.53	13.67
Fluqvinconazole 125 g ha^{-1}	97.8	100	100	4.93	6.95	13.73
Metconazole 90 g ha^{-1}	62.2	75.6	93.3	0.98	2.29	3.73
LSD $_{05}$ / R_{05}	20.68	19.70	7.62	3.529	3.049	3.816

Table 7. Incidence and severity of Septoria leaf blotch in winter wheat in relation to reduced dosage of fungicides at water ripe stage (BBCH 71)
7 lentelė. *Septoriozės išplitimas ir intensyvumas žieminiuose kviečiuose grūdo formavimosi pradžios tarpsniu, panaudojus sumažintas fungicidų normas*
Dotnuva, 2000

Treatment *Variantas*	F			F-1			F-2		
	1/1	¾	½	1/1	¾	½	1/1	¾	½
	Incidence % / *Išplitimas %*								
Untreated / *Nepurkšta*	20.0	3.4	11.7	51.6	45.0	55.0	85.0	85.0	83.4
Cyrpoconazole 80 g ha^{-1}	1.7	0	0	15.0	5.0	13.3	56.7	45.0	56.6
Tebuconazole 250 g ha^{-1}	0	0	0	0	0	3.3	5.0	3.4	15.0
Propiconazole 125 g ha^{-1}	0	0	0	1.7	1.7	3.4	30.0	43.4	30.0
Flutriafol 125 g ha^{-1}	0	0	0	0	3.3	5.0	8.3	20.0	30.0
Fluqvinconazole 125 g ha^{-1}	0	1.7	0	0	3.4	0	11.6	8.4	20.0
Metconazole 90 g ha^{-1}	0	0	0	0	0	0	6.6	6.7	16.6
LSD $_{05}$ / R_{05}	5.70	2.88	5.18	11.61	11.57	8.41	19.12	19.71	24.57
	Severity % / *Intensyvumas %*								
Untreated / *Nepurkšta*	0.20	0.04	0.12	0.72	0.73	0.95	4.38	3.04	4.22
Cyrpoconazole 80 g ha^{-1}	0.02	0	0	0.15	0.05	0.20	0.70	0.72	1.32
Tebuconazole 250 g ha^{-1}	0	0	0	0	0	0.03	0.05	0.10	0.22
Propiconazole 125 g ha^{-1}	0	0	0	0.02	0.02	0.04	0.36	0.57	0.43
Flutriafol 125 g ha^{-1}	0	0	0	0	0.03	0.05	0.08	0.26	0.72
Fluqvinconazole 125 g ha^{-1}	0	0.02	0	0	0.04	0	0.12	0.08	0.33
Metconazole 90 g ha^{-1}	0	0	0	0	0	0	0.06	0.07	0.23
LSD $_{05}$ / R_{05}	0.095	0.029	0.052	0.207	0.154	0.141	0.695	0.506	0.847

Table 8. Incidence and severity of Septoria leaf blotch in winter wheat in relation to reduced dosage of fungicides at late milk stage (BBCH 77)
8 lentelė. *Septoriozės išplitimas ir intensyvumas žieminiuose kviečiuose pieninės brandos pabaigos tarpsniu, panaudojus sumažintas fungicidų normas*
Dotnuva, 2000

Treatment *Variantas*	BBCH 77					
	Incidence % / *Išplitimas %*			Severity % / *Intensyvumas %*		
	1/1	¾	½	1/1	¾	½
Untreated / *Nepurkšta*	100	100	100	18.30	19.28	18.44
Cyrpoconazole 80 g ha^{-1}	100	100	97.5	10.34	14.21	16.50
Tebuconazole 250 g ha^{-1}	74.8	80.2	88.5	3.88	3.25	5.96
Propiconazole 125 g ha^{-1}	88.1	94.9	100	5.65	6.49	9.46
Flutriafol 125 g ha^{-1}	94.3	97.6	96.6	7.45	10.03	13.70
Fluqvinconazole 125 g ha^{-1}	95.0	97.0	99.1	10.02	8.22	8.02
Metconazole 90 g ha^{-1}	76.3	78.2	94.2	4.38	3.77	6.14
LSD $_{05}$ / R_{05}	14.65	15.38	7.32	2.340	4.000	4.656

In 2000 due to the hot weather conditions tan spot in winter wheat stands appeared before heading. At the beginning of heading the solitary spots were observed on 8 % flag leaves and 4 % F-2, and the incidence of the disease was found on 20 % F-1 leaves. This year the higher disease incidence on F-1 than on F-2 show the character of airborne tan spot infection too. Three weeks after application, at water ripe stage the incidence and severity of tan spot in untreated plots was similar to that in 1999. There were injured more than half

leaves, but the disease severity was low and covered only 0.50-0.93 % leaf surface (Table 9). Tebuconazole and Metconazole sufficiently reduced the incidence and severity of tan spot on flag and F-1 leaves, Propiconazole – only on flag leaf. The efficacy of Cyproconazole, Fluqvinconazole and Flutriafol was insufficient. But all the tested triazoles had insufficient effect on the incidence and severity of tan spot on F-2 leaves. Late in the season the incidence of tan spot was intensive. At late milk (BBCH 77) all flag leaves were diseased, and the disease severity amounted to 3.25-5.60 % (Table 10). All the tested triazoles did not have any effect on the incidence of tan spot, but reduced the severity of the disease. Cyproconazole reduced to three/quarters dose and Flutriafol and Fluqvinconazole reduced to half doses were insufficient against the severity of tan spot.

Table 9. Incidence and severity of tan spot in winter wheat in relation to reduced dosage of fungicides at early milk stage (BBCH 73)
9 lentelė. *Kviečių dryžligės išplitimas ir intensyvumas žieminiuose kviečiuose pieninės brandos pradžios tarpsniu, panaudojus sumažintas fungicidų normas*

Dotnuva, 1999

Treatment *Variantas*	F			F-1			F-2		
	1/1	¾	½	1/1	¾	½	1/1	¾	½
Incidence % / *Išplitimas %*									
Untreated / *Nepurkšta*	80.0	60.0	71.1	77.8	73.3	73.3	53.1	34.8	54.3
Cyrpoconazole 80 g ha^{-1}	53.4	51.1	51.1	45.5	60.0	46.7	30.6	44.4	40.2
Tebuconazole 250 g ha^{-1}	24.4	31.1	31.1	37.8	35.6	37.8	22.6	22.7	22.0
Propiconazole 125 g ha^{-1}	42.2	44.4	46.7	28.9	35.6	51.1	13.9	33.0	23.2
Flutriafol 125 g ha^{-1}	53.3	48.9	48.9	44.4	64.4	60.0	47.6	49.2	35.4
Fluqvinconazole 125 g ha^{-1}	42.2	53.3	51.1	66.7	51.1	62.2	44.7	38.7	45.0
Metconazole 90 g ha^{-1}	31.1	35.6	46.7	35.6	48.9	40.0	37.0	19.2	24.9
LSD_{05} / R_{05}	17.84	24.04	27.62	21.67	22.21	22.54	26.19	16.63	26.99
Severity % / *Intensyvumas %*									
Untreated / *Nepurkšta*	0.90	0.60	0.70	0.93	0.73	0.73	0.63	0.40	0.50
Cyrpoconazole 80 g ha^{-1}	0.57	0.50	0.50	0.47	0.60	0.47	0.30	0.53	0.43
Tebuconazole 250 g ha^{-1}	0.23	0.30	0.30	0.40	0.37	0.37	0.20	0.23	0.19
Propiconazole 125 g ha^{-1}	0.40	0.43	0.50	0.30	0.37	0.50	0.23	0.43	0.26
Flutriafol 125 g ha^{-1}	0.53	0.47	0.50	0.43	0.63	0.60	0.50	0.50	0.37
Fluqvinconazole 125 g ha^{-1}	0.40	0.53	0.50	0.67	0.60	0.63	0.43	0.37	0.43
Metconazole 90 g ha^{-1}	0.33	0.37	0.47	0.37	0.60	0.40	0.40	0.17	0.22
LSD_{05} / R_{05}	0.172	0.237	0.252	0.318	0.276	0.274	0.342	0.223	0.275

Brown rust in 1999 appeared in winter wheat stands late, only at the beginning of grain filling stage. At early milk only initial pustules on upper three leaves were found. Fungicide-treated plots were clean of brown rust, only some pustules in Propiconazole and Flutriafol treatments were found (Table 11). The spread of brown rust that year was not intensive. At late milk there were injured 31.1-44.5 % of flag leaves and the disease severity covered as little as 0.31-0.73 % leaf surface. Only reduced doses of Propiconazole and Flutriafol insufficiently affected the incidence of brown rust and showed lower efficacy against the severity of the disease. The other fungicides were highly effective against brown rust.

Table10. Incidence and severity of tan spot in winter wheat in relation to reduced dosage of fungicides at late milk stage (BBCH 79)

10 lentelė. *Kviečių dryžligės išplitimas ir intensyvumas žieminiuose kviečiuose pieninės brandos pabaigos tarpsniu, panaudojus sumažintas fungicidų normas*

Dotnuva, 1999

Treatment *Variantas*	BBCH 79					
	Incidence % / *Išplitimas %*			Severity % / *Intensyvumas %*		
	1/1	¾	½	1/1	¾	½
Untreated / *Nepurkšta*	100	100	97.8	3.04	2.36	2.15
Cyrpoconazole 80 g ha^{-1}	97.8	97.8	100	1.51	1.60	1.62
Tebuconazole 250 g ha^{-1}	68.9	91.1	75.6	0.69	1.00	0.93
Propiconazole 125 g ha^{-1}	77.8	93.3	86.7	0.78	1.29	1.05
Flutriafol 125 g ha^{-1}	86.7	93.3	95.5	0.96	1.29	0.95
Fluqvinconazole 125 g ha^{-1}	86.7	97.8	86.6	0.96	1.69	1.15
Metconazole 90 g ha^{-1}	86.7	86.7	86.7	0.87	0.87	1.05
LSD $_{05}$ / R_{05}	15.26	11.28	10.46	0.719	0.776	0.713

Table 11. Incidence and severity of tan spot in winter wheat in relation to reduced dosage of fungicides at water ripe stage (BBCH 71)

11 lentelė. *Kviečių dryžligės išplitimas ir intensyvumas žieminiuose kviečiuose grūdo formavimosi pradžios tarpsniu, panaudojus sumažintas fungicidų normas*

Dotnuva, 2000

Treatment *Variantas*	F			F-1			F-2		
	1/1	¾	½	1/1	¾	½	1/1	¾	½
	Incidence % / *Išplitimas %*								
Untreated / *Nepurkšta*	53.3	60.0	78.4	80.0	80.0	93.3	38.3	50.0	56.7
Cyrpoconazole 80 g ha^{-1}	40.0	46.7	48.3	78.4	75.0	80.0	55.0	46.7	65.0
Tebuconazole 250 g ha^{-1}	20.0	26.7	28.4	60.0	58.3	71.7	40.0	43.3	60.0
Propiconazole 125 g ha^{-1}	26.7	28.3	40.0	63.4	66.7	83.3	38.4	46.6	43.3
Flutriafol 125 g ha^{-1}	30.0	48.3	60.0	65.0	80.0	86.6	50.0	55.0	56.6
Fluqvinconazole 125 g ha^{-1}	51.6	43.3	50.0	75.0	81.7	75.0	48.4	58.3	63.6
Metconazole 90 g ha^{-1}	18.4	23.3	28.4	41.6	48.3	55.0	38.4	50.0	56.7
LSD $_{05}$ / R_{05}	21.47	19.71	21.37	18.97	19.24	18.70	21.60	17.97	16.49
	Severity % / *Intensyvumas %*								
Untreated / *Nepurkšta*	0.53	0.60	0.78	0.80	0.80	0.93	0.38	0.50	0.64
Cyrpoconazole 80 g ha^{-1}	0.40	0.47	0.48	0.78	0.75	0.80	0.55	0.47	0.72
Tebuconazole 250 g ha^{-1}	0.20	0.27	0.28	0.60	0.58	0.72	0.40	0.43	0.62
Propiconazole 125 g ha^{-1}	0.27	0.28	0.40	0.64	0.66	0.83	0.38	0.46	0.43
Flutriafol 125 g ha^{-1}	0.30	0.48	0.60	0.65	0.80	0.87	0.50	0.55	0.56
Fluqvinconazole 125 g ha^{-1}	0.52	0.43	0.50	0.75	0.82	0.75	0.48	0.58	0.63
Metconazole 90 g ha^{-1}	0.18	0.23	0.28	0.42	0.48	0.55	0.38	0.50	0.57
LSD $_{05}$ / R_{05}	0.215	0.197	0.213	0.189	0.192	0.187	0.216	0.179	0.186

In 2000 the spread of brown rust was earlier than in 1999. At the beginning of heading disease symptoms were found on 4 % F-1 and 16 % on F-2 leaves. At water ripe in untreated plots brown rust incidence was 37.2-50.5 % on upper three leaves, the disease severity was 0.57-1.0 % of the leaf surface (Table 12). All the tested triazoles sufficiently reduced the incidence and severity of the disease, but the reduced doses of Flutriafol and Propiconazole showed suppressing effect on brown rust that year, too. Late in the season the spread of brown rust was intensive. At late milk (BBCH 77) stage in untreated plots 68.6-81.2 % flag leaves were diseased and the disease severity amounted to 3.38-4.37 %. All fungicides were highly effective against brown rust except for reduced doses of Flutriafol

and Propiconazole. These triazoles did not affect the incidence of brown rust and showed lower efficacy against the disease severity. The leaf rust epidemic can be prevented by a single spray application with fungicides containing Epoxiconazole, Tebuconazole, or Cyproconazole. The spray is applied before the rust infection exceeds 5-10 % on upper three leaves /Fuzi, 1997/.

Due to full and reduced to ¾ dosages of triazole fungicides we obtained a sufficient yield increase annually (Table 13). In 1999 the grain yield increase in all treatments through the use of reduced dosage to ½ was insufficient, but in 2000 in the plots applied with Tebuconazole, Metconazole and Fluqvinconazole a significant yield increase was obtained.

Table12. Incidence and severity of tan spot blotch in winter wheat in relation to reduced dosage of fungicides at late milk stage (BBCH 77)
12 lentelė. *Kviečių dryžligės išplitimas ir intensyvumas žieminiuose kviečiuose pieninės brandos pabaigos tarpsniu, panaudojus sumažintas fungicidų normas*

Dotnuva, 2000

Treatment *Variantas*	BBCH 77					
	Incidence % / *Išplitimas %*			Severity % / *Intensyvumas %*		
	1/1	¾	½	1/1	¾	½
Untreated / *Nepurkšta*	100	100	100	5.60	4.27	3.25
Cyrpoconazole 80 g ha^{-1}	100	100	100	3.12	3.14	2.34
Tebuconazole 250 g ha^{-1}	94.9	90.0	89.4	1.94	1.71	1.86
Propiconazole 125 g ha^{-1}	92.1	91.7	98.1	1.57	1.76	1.78
Flutriafol 125 g ha^{-1}	100	98.8	96.6	2.56	2.38	2.38
Fluqvinconazole 125 g ha^{-1}	100	99.0	96.2	3.62	3.03	2.62
Metconazole 90 g ha^{-1}	94.8	97.2	98.0	1.66	1.39	1.61
LSD $_{05}$ / R_{05}	13.38	24.63	8.28	0.700	1.136	1.079

Table 13. The influence of reduced dosage of triazole fungicides on winter wheat grain yield and 1000 grain weight
13 lentelė. *Sumažintų triazolų grupės fungicidų normų įtaka žieminių kviečių derlingumui ir 1000 grūdų masei*

Dotnuva, 1999

Treatment *Variantas*	Grain yield t ha^{-1} / *Derlingumas t* ha^{-1}			1000 grain weight g / *1000 grūdų masė g*		
	1/1	¾	½	1/1	¾	½
1999						
Untreated / *Nepurkšta*	5.27	5.38	5.60	42.76	42.95	43.18
Cyrpoconazole 80 g ha^{-1}	5.70	5.64	5.44	43.81	43.09	42.79
Tebuconazole 250 g ha^{-1}	6.16	6.17	6.01	44.43	45.35	44.09
Propiconazole 125 g ha^{-1}	5.69	5.79	5.79	44.88	44.25	44.81
Flutriafol 125 g ha^{-1}	5.72	5.83	5.72	44.12	44.81	43.56
Fluqvinconazole 125 g ha^{-1}	5.84	5.80	5.68	44.40	43.96	43.52
Metconazole 90 g ha^{-1}	5.85	5.80	5.75	44.07	44.43	44.62
LSD $_{05}$ / R_{05}	0.337	0.262	0.434	1.151	1.274	1.211
2000						
Untreated / *Nepurkšta*	5.84	5.98	6.10	48.54	48.65	47.06
Cyrpoconazole 80 g ha^{-1}	6.20	6.42	6.25	50.01	48.65	47.17
Tebuconazole 250 g ha^{-1}	6.45	6.59	6.44	49.61	50.48	48.71
Propiconazole 125 g ha^{-1}	6.13	6.37	6.29	50.42	49.34	47.96
Flutriafol 125 g ha^{-1}	6.25	6.33	6.27	49.68	49.62	47.59
Fluqvinconazole 125 g ha^{-1}	6.36	6.65	6.53	50.16	49.77	48.62
Metconazole 90 g ha^{-1}	6.49	6.63	6.79	50.24	50.62	48.64
LSD $_{05}$ / R_{05}	0.283	0.313	0.283	1.981	1.102	1.081

The grain yield increase was obtained due to 1000 grain weight increase. In 1999 in all treatments applied with full dose (except Cyproconazole) and three/quarts dose (except Fluqvinconazole) the 1000 grain weight increased sufficiently. But in 2000 in most treatments only a tendency of the increasing of 1000 grain weight was observed. The implication is that the reduced to ½ dosage of fungicides in the case of disease sudden outbreaks could not provide an adequate control until the end of grain filling without increasing the risk of yield losses.

Conclusions

At the time of investigation powdery mildew appeared in the winter wheat in early spring. But later the spread of the disease was suppressed by dry weather conditions. After early milk the spread of the disease was depressed. In the case of mildew appearance in the field after flag leaf emergence the sprays during the period BBCH 39-59 gave the best disease control on leaves and ears and the highest yield increase. Full and reduced doses of the tested triazole fungicides suppressed the incidence and severity of powdery mildew on flag leaves and the disease severity on F-1 and F-2 leaves. The tendency was revealed that the efficacy of fungicides was higher in the treatments where the disease incidence and severity were higher in the control plots. The efficacy of full doses of triazoles was higher than that of reduced doses.

In winter wheat stands *Stagonospora nodorum* prevailed in both years. The incidence and severity of Septoria leaf blotch both in 1999 and 2000, were higher in the treatments with reduced doses of fungicides. At high infection level in 1999, 30 days after application at late milk stage the full and the reduced doses of Cyproconazole, Flutriafol and Fluqvinconazole did not affect the incidence of the disease, and the reduced doses provided only a slight effect on the severity of Septoria leaf blotch. Due to the lower disease pressure in 2000 even 48 days after application the reduction of the disease severity with reduced doses of fungicides was sufficient; only except for the half dose treatment of Cyproconazole.

Tan spot infection in the years of investigation was mainly airborne. The two upper leaves were injured by the disease more intensively than the third leaf. Against tan spot full and reduced doses of Tebuconazole and Metconazole showed a sufficient efficacy. The efficacy of reduced doses of Cyproconazole, Fluqvinconazole, and Flutriafol was insufficient.

The spread of brown rust in 1999 was late and slow, but in 2000 rather early. All fungicides were highly effective against brown rust except for reduced doses of Flutriafol and Propiconazole. These triazoles did not affect the incidence of brown rust and showed lower efficacy against the disease severity.

Investigation of the incidence and severity of leaf diseases in winter wheat in relation to reduced dosage of fungicides suggested that reduction of the rate of triazole fungicides to half dose can be insufficient and economically risky. The reduced fungicide dosage to ½ showed a higher level of control in the first 2-3 weeks after application, but in the case of disease sudden outbreaks could not provide an adequate control until the end of grain filling without increasing the risk of yield losses.

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ŽIEMINIŲ KVIEČIŲ LAPŲ LIGŲ KONTROLĖ NAUDOJANT SUMAŽINTAS TRIAZOLŲ NORMAS

I.Gaurilčikienė

S a n t r a u k a

Šešių triazolų grupės fungicidų sumažintų normų veiksmingumo nuo lapų ligų tyrimai žieminių kviečių ‘Zentos’ pasėlyje atlikti 1999-2000 m. Miltligė (*Blumeria graminis* (DC) Spear.) žieminiuose kviečiuose gausiai išplito 1999 m., bet 2000 m. reiškėsi silpnai. Visos ir sumažintos iki ½ ir ¾ fungicidų normos gerai kontroliavo miltligės išplitimą ir intensyvumą, ypač ant viršutinių augalų lapų. Septoriozė (*Septoria* spp.) ir kviečių dryžligė (*Pyrenophora tritici repentis* (Died.)Drechs.) žieminiuose kviečiuose plito kasmet. Nuo septoriozės visos ir sumažintos fungicidų normos buvo labai veiksmingos iki ankstyvos pieninės brandos, ypač gerai saugojo viršutinius augalų lapus. Vėlyvos pieninės brandos metu nuo septoriozės sumažintos fungicidų normos buvo mažiau veiksmingos nei visos. Nuo kviečių dryžligės buvo veiksmingos tik visos fungicidų normos, sumažintų normų efektyvumas buvo menkas. Tiek visos, tiek sumažintos fungicidų normos buvo labai veiksmingos nuo rudųjų rūdžių (*Puccinia recondita*). Esminis žieminių kviečių derliaus padidėjimas buvo gautas nuo visų ir sumažintų iki ¾ fungicidų normų vartojimo. Derliaus padidėjimas nuo iki ½ sumažintų normų buvo nedidelis ir neesminis. Derliaus priedas naudojant fungicidus buvo gautas padidėjus 1000 grūdų masei.

Reikšminiai žodžiai: žieminiai kviečiai, triazolų grupės fungicidai, normos, lapų ligos, grūdų derlius.