JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 44, No. 2 (2004)

GRAIN YIELD OF WINTER WHEAT AND ITS QUALITY IN RELATION TO FUNGAL DISEASE DEVELOPMENT AND CLIMATIC CONDITIONS IN 2000–2003

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Accepted: April 21, 2004

Abstract: For producers of winter wheat the main purpose is to obtain high yield ensuring profitability. However, as the grain yield is concerned, profitability depends to a considerable degree upon its high quality giving a chance to obtain a higher selling price. The high grain quality is influenced by numerous factors. In the performed research work the influence of climatic conditions and intensity of the development of fungal diseases on leaves, ears and stem bases was investigated. Four-year plot experiments with winter wheat cvs. Kobra and Mikon were conducted in the Agricultural Experimental Station of Warsaw Agricultural University at Chylice, Mazowieckie voivodeship. Fungicidal treatments were performed twice, at shooting phase (GS 30) and at the beginning of earing (GS 51) using the newest plant protection products designed for controlling complex of fungal diseases on winter wheat. Weather conditions in the experimental years were differentiated. This was particularly related to the periods of intensive growth and ripening of winter wheat (April – July), while the deficiency of rainfall markedly influenced the development of fungal diseases, as well as the quality of grain. In 2000 a severe drought occurred, in the years 2001 and 2003 weather conditions were similar to standard values, and in 2002 this period was characterised by relatively low rainfall. The above conditions affected the occurrence and severity of fungal diseases, as well as the amount and quality of grain yield. In the years 2000–2003 winter wheat grain yield in treatments with fungicidal protection was higher on average by 26.12% in the interval from 7.34% to 53.15% and thousand grain weight was higher on average by 11.47% in the interval from 2.00% to 22.12%.

Key words: winter wheat, grain quality, fungal diseases, weather conditions

INTRODUCTION

Cereals are cultivated in Poland on about 70% of total arable land and at least in 90% of agricultural farms. Because of this profitability of their cultivation influences the economic situation of Polish agriculture. Profit derived from cereal cultivation is dependent on the amount of obtained grain yield, and above all on the quality of grain. Quality requirements are posed by cereal producers in a view of sowing material, and also by consumers and cattle breeders (Solarski 2002; Podolska and Sułek 2003).

Numerous factors are essential for obtaining high grain yield and its good quality. The most important of them are: environmental conditions (quality of soils, atmospheric precipitation, insolation), genetic potential of cultivated varieties, and agricultural factors (date of sowing, fertilisation, protection of cultures) which are to the highest degree dependent on a producer (Rozbicki 2002).

Created by breeders new varieties become the carriers of progress and of the increase of production, both in quantitative and qualitative aspect. However, at least 40% share of qualified sowing material enables the transfer breeders' achievements to producers. The total share of qualified sowing material in Poland is 13.5% which means that in practice every third agricultural farm can take adventage of biological progress (Arseniuk 2002; Oleksiak 2002). In this situation it is important to obtain in the process of production wheat grain of a high quality wich could also be used as sowing material (Gan et al. 1992; Clear and Patrick 1993; Baalbaki and Copeland 1997). While choosing cereal varieties for production, their resistance to disease is a characteristic of principal importance. Winter wheat is a species particularly susceptible to the infection by pathogenic fungi, which can be cause a decrease of grain yield as well as make worse its quality (Nelson et al. 1976; Patterson et al. 1990; Shah et al. 1995; Głazek and Jańczak 1998; Korbas and Ławecki 2003).

In this paper data are presented on the influence of meteorological conditions in 4 vegetative periods (2000–2003) on the amount and quality on winter wheat yield, and the possibilities of improving grain quality as influenced by correct plant protection methods.

MATERIAL AND METHODS

The objective of performed research was winter wheat cv. Kobra (2000) and cv. Mikon (2001–2003) naturally infested by pathogenic fungi, and the effect of resulting diseases on the amount and quality of grain yield. Experiments were performed on 25 sq. m plots in 4 repetitions, on the soil class III, in the Agricultural Experimental Station of Warsaw Agricultural University Chylice, Mazowieckie woivodeship. Agricultural and sanitary practices were carried out according to the recommendations of the Institute of Soil Science and Plant Cultivation and the Institute of Plant Protection. Each year cereals were cultivated as a previous crop. To reduce the development of fungal diseases on leaves, ears and stem base of winter wheat two treatments with fungicides were performed: the first treatment at the stage of winter wheat GS 30 (shooting) using fungicides containing biologically active ingredients – azoxystrobin, prochloraz, or flusilazole + carbendazim; the second treatment was performed at the stage of growth GS 51 (earing) using the newest fungicides containing the following biologically active ingredients – azoxystrobin, metkonazole, cyprokonazole + trifloxystrobin, flusilazole + famoxad, krezoxim-methyl + epoxikonazole, propikonazole + cyprokonazole, propikonazole + carbendazim, epoxykonazole + krezoxim-methyl + fenpropimorph, and tebukonazole + spiroxamine + triadimenol. Control consisted of non-sprayed with fungicides plots.

The appearance and development of fungal diseases occurring on various winter wheat organs (leaves, ears, stem bases) were estimated on the basis of visual assessment and microscopic examination. For mycological analysis 100 main culms from each treatment were taken. Infection of leaves was estimated as mean % of infected area of two upper leaves (L_1 and L_2), at the phase of milky ripeness of grain (GS 75). Per cent of green leaf area (GLA) was also estimated on the same leaves.

The infection of ears was expressed as mean % of infected ear area at the phase of full ripeness of grain (GS 91). The occurrence of stem base infection was determined at the same phase of growth. Index of infection by *Tapesia yallundae* Wallwork et Spooner [anamorph *Pseudocercosporella herpotrichoides* (Fron) Deighton], the cause of eyespot, was determined according to the generally accepted formula (Scott and Hollins 1974), and the infection by *Fusarium* spp. and *Rhizoctonia* spp. was determined as mean % of infected culm bases. Prior to the harvest from each plot 3 samples of 25 ears each were taken to calculate grain yield parameters. After harvest grain yield and its components were determined. Obtained results were subjected to analysis of variance. Meteorological data were taken from the station Ekomet located on the territory of the Agricultural Experimental Station Chylice.

RESULTS AND DISCUSSION

Weather conditions in the years 2000–2003 were highly differentiated, especially at the time of grain formation and ripening (Tab. 1). While comparing the measurements of air temperatures and rainfall, which were obtained from the meteorological station located in the range of the experimental field, with mean long-term average (1971–2000), it was stated that the season 1999/2000 was

Table 1. Meteorological conditions at the Experimental Station of Warsaw Agricultural University Chylice from 1999/2000 to 2002/ 2003 as compared with long-term averages

Month	Average temperature °C					Total rainfall (mm)				
	2000	2001	2002	2003	1971–2000 mean	2000	2001	2002	2003	1971–2000 mean
September	17.1	9.9	12.0	13.3	13.0	34.6	45.6	70.5	77.8	48.9
October	8.8	9.2	11.3	6.5	8.1	44.2	7.1	29.7	72.8	38.2
November	1.3	4.1	2.7	4.5	2.8	14.0	55.4	34.8	38.9	36.5
December	1.1	1.4	–4.0	–6.2	–0.4	27.4	41.5	28.9	11.0	34.5
January	–1.5	–0.7	–1.2	–6.0	–2.2	26.1	22.6	26.8	26.4	22.1
February	2.4	–0.8	3.9	–4.7	–1.2	34.1	25.7	71.5	15.7	22.0
March	3.2	1.7	4.9	0.9	2.6	53.1	28.2	42.2	17.5	28.1
April	11.8	3.1	8.5	6.6	7.9	11.5	92.5	11.1	32.5	34.7
May	15.1	11.5	17.4	15.4	13.7	22.9	21.6	66.4	70.9	50.7
June	17.8	11.9	17.3	17.5	16.5	9.2	64.3	71.7	47.3	71.2
July	16.0	18.4	20.3	19.5	18.1	160.1	104.3	43.0	68.1	73.2
August	16.9	19.0	20.1	17.6	17.7	55.0	27.1	40.4	45.0	58.9

broadly characterized by higher air temperatures exceeding long-term average, and lower amount of rainfall. When related to specific periods of the season 1999/2000, it can be stated that the autumn was warm and relatively dry, the winter was mild with atmospheric precipitation slightly exceeding the norm, the spring was warm and dry, and June and the first part of July of 2000 was characterized by severe drought and temperature approaching the norm. High rainfall was recorded as late as at the end of July, after winter wheat harvest.

The vegetative period of 2000/2001 was characterized by warm autumn with rainfall close to the norm, very mild winter with abundant atmospheric precipitation, warm and humid spring and hot dry summer, especially in July of 2002, with rainfall below the norm. Weather conditions in this vegetative season were close to optimal for winter wheat.

In the last of investigated vegetative period 2002/2003 the autumn was warm with abundant rainfall highly exceeding the norm, the winter was severe and characterised by difficiency of atmospheric precipitation, the spring was relatively cool with rainfall close to the norm, and the summer was warm and relatively dry.

It is generally accepted that the optimal course of weather for winter wheat is: warm and humid autumn, mild winter, warm and humid spring and hot and dry summer (Rozbicki 2002). In the period under study each year was more or less different when compared to accepted optimum. The course of weather is quite significant in the view of the disease occurrence and intensity of development of fungal diseases on leaves, ears and stem bases of winter wheat. As a result, considerable differences were recorded each year in the investation of particular plant organs by pathogenic fungi.

While estimating the infection of winter wheat leaves (mean % of infection of 2 upper leaves) at the stage of milky ripeness (GS 75) it was stated that in the years 2001 and 2002 leaf rust caused by *Puccinia recondita* Rob. ex Desm. f. sp. *tritici* (Erikss.) Johnson was a dominant disease. The highest leaf infection (44.79% leaf area infected in untreated with fungicides control) was recorded in 2001, when the occurrence of this disease was also high on the whole territory of Poland. Also in 2002 leaf rust affected 37.13% leaf area. Such high infection in the years 2001 and 2002 resulted in a considerable reduction of green leaf area (GLA) by 48.38% and 32.37%, respectively, in the untreated control. Cultivated varieties also proved to be susceptible to *Septoria* spp. which were the cause of leaf blotch of winter wheat. These species: *Stagonospora nodorum* (Berk.) Castellani et Germano syn. *Septoria nodorum* (Berk.) Berk. and *Septoria tritici* Rob. ex Desm. dominated in the year 2003 (13.89% leaf area affected). The fungus *Blumeria graminis* (DC) Speer syn. *Erysiphe graminis* DC, the casual agent of powdery mildew of cereals and grasses occurred at a low intensity not exceeding 5% leaf area affected in any of the years under study. Tan spot of winter wheat leaves caused by the fungus *Pyrenophora tritici-repentis* (Died.) Drechsler [anamorph *Drechslera tritici-repentis* (Died.) Schoemaker] was not a dominant disease in the years 2000–2003. In every year the application of 2 fungicidal sprays effectively confined the development of all diseases occurring on the leaves (Tab. 2).

The infection of winter wheat ears was also differentiated, mainly because of weather conditions in the period of grain formation and maturation (June, July). In

Table 2. Fungal diseases occurring on winter wheat leaves in 2000–2003

Year	Objects	Mean % of infected surface of 2 upper leaves (L_1 + L_2) at GS 75				Total infected leaf surface %	GLA* %
		Blumeria graminis	*Puccinia recondita*	*Septoria* spp.	*Pyrenophora tritici-repentis*		
2000	Protected with fungicides	0.35 a	0.26 a	3.25 a	0.78 a	4.64	43.79 ab
	Untreated	4.04 b	19.24 b	16.29 b	9.13 b	48.70	56.28 b
	LSD (0.05)	0.25	2.88	1.18	0.76		13.10
2001	Protected with fungicides	0.36 a	0.89 a	1.34 ab	1.02 ab	3.61	84.05 a
	Untreated	3.45 b	44.79 c	10.32 c	5.76 d	64.32	40.38 c
	LSD (0.05)	0.37	2.13	0.83	0.44		6.39
2002	Protected with fungicides	0.26 abc	0.94 ab	0.43 ab	0.05 a	1.68	98.74 ab
	Untreated	3.38 d	37.13 c	14.32 c	4.18 b	59.01	32.37 c
	LSD (0.05)	0.29	1.41	0.62	0.46		2.76
2003	Protected with fungicides	0.12 a	0.00 a	1.10 ab	0.38 a	1.60	91.40 ab
	Untreated	3.29 b	2.09 b	13.89 c	4.94 b	24.21	77.82 c
	LSD (0.05)	0.49	0.73	1.35	0.65		9.44

GLA* – % green leaf area; GS 75 – growth stage milky ripe
Values followed by the same letters are not significantly different at the level p = 0.05

all the years under study a dominant species was *S. nodorum*, the casual agent of glume blotch of wheat. In the most favourable year 2001 for the development of this disease the infection of ear area amounted to 23.78%. A considerable differentiation of winter wheat ear infection was stated in the case of fusariosis (*Fusarium* spp.). The most severe infection of ear area was observed in 2001 (4.27%) and in 2002 (3.45%), this was a result of favourable weather conditions for the development of the disease. On the ears of winter wheat in the year 2000 and 2001, shortly before harvest, the most intense development of sooty moulds (mainly *Cladosporium* spp. and *Alternaria* spp.) was observed, which was a result of high rainfall in July. However, the importance of this phenomenon could be defined as negligible because of a low harmfulness of these fungi, usually playing the role of saprophytes or weak parasites. Applied fungicides effectively confided the development of the majority of diseases occurring on winter wheat ears, with the exception of the year 2001, when the reduction of sooty moulds was not satisfactory (Tab. 3).

A marked influence on the quality of winter wheat grain is attributed to the fungi developing on basal part of stems. The fungus *Tapesia yallundae* Wallwork and Spooner [anamorph *Pseudocercosporella herpotrichoides* (Fron) Deighton] occurred at the highest intensity in 2002, after a very mild winter with abundant atmospheric precipitation (infection index 18.00). In those conditions the pathogen was able to develop during the whole resting period of plants, as the optimal temperature for its sporulation is around 5°C. However, more severe winter conditions confined the development of this pathogen (Jaczewska-Kalicka 1998). Brown foot-rot caused by complex of the fungi from the genus *Fusarium* is related to simplified rotation in cereal cultivation. In the experimental period where winter wheat was always cultivated after a cereal previous crop, every year a high degree of infestation of culm bases by *Fusarium* spp. was usually stated. It ranged from 27% infected culm bases

Table 3. Fungal diseases occurring on winter wheat ears in 2000–2003

Year	Objects	Mean infected surface of ears at GS 92				Total infected ear surface %
		Blumeria graminis	*Septoria nodorum*	*Fusarium* spp.	*Alternaria spp. Cladosporium* spp.	
2000	protected with fungicides	0.18 ab	0.34 a	0.07 ab	7.57 abc	8.16
	untreated	0.69 c	2.72 b	0.53 c	25.69 d	29.63
	LSD (0.05)	0.15	0.37	0.09	3.62	
2001	protected with fungicides	1.20 ab	4.74 ab	1.37 a–d	20.47 a–e	27.78
	untreated	5.25 c	23.78 c	4.27 e	29.43 cd	62.73
	LSD (0.05)	0.54	1.24	0.38	2.45	
2002	protected with fungicides	0.07 ab	1.04 a–d	1.91 a–d	0.00	3.02
	untreated	1.61 c	7.34 e	3.45 e	0.00	12.40
	LSD (0.05)	0.07	0.32	0.48		
2003	protected with fungicides	0.07 a	0.82 ab	0.01 a	0.82 abc	1.72
	untreated	0.59 b	4.87 c	0.12 b	3.24 d	8.82
	LSD (0.05)	0.15	0.39	0.05	0.54	

GS 92 – growth stage fully ripe
Values followed by the same letters are not significantly different at the level p = 0.05

in the year 2000 to 54% infected culm bases in the year 2001. Applied fungicides were not always effective in the control of this disease. On the basal part of culms the presence of the fungus *Rhizoctonia cerealis* van der Hoeven (teleomorph *Ceratobasidium cereale* Murray et Burpee), the casual agent of sharp eyespot of cereals was also stated. In general, this fungus occurred at a low intensity (Tab. 4).

The results of 4-year study confirmed a considerable effect of weather conditions on the amount and quality of grain yield expressed as weight of 1000 grains. Weather conditions influenced the growth and condition of cultivated plants as well as the development of pathogens, which can also markedly confine the amount of yield and its quality. Such conditions existed especially in the year 2001 (Tab. 1),

Table 4. Fungal diseases occurring on winter wheat stem bases in 2000–2003

Year	Objects	*Tapesia yallundae* – index	Mean % of infection of stem bases at GS 92	
			Fusarium spp.	*Rhizoctonia* spp.
2000	Protected with fungicides	1.20 a	19.00 a	2.00 a
	Untreated	3.33 b	27.00 a	2.20 a
	LSD (0.05)	1.44	16.92	1.43
2001	Protected with fungicides	5.33 a	21.60 abc	2.30 ab
	Untreated	6.33 a	54.00 d	8.50 b
	LSD (0.05)	8.53	9.68	5.12
2002	Protected with fungicides	5.00 a	25.00 abe	2.00 ab
	Untreated	18.00 b	36.00 d	8.00 b
	LSD (0.05)	5.96	6.05	4.49
2003	Protected with fungicides	0.40 a	24.00 a	0.20 a
	Untreated	4.67 b	42.00 b	1.00 a
	LSD (0.05)	1.56	12.47	1.80

Values followed by the same letters are not significantly different at the level p = 0.05

when total leaf infection amounted to 64.32% of infected leaf area – including 44.79% leaf infection by brown rust (Tab. 2). On ears the infection caused by *S. nodorum* amounted to 23.78% of infected glume area (Tab. 3) and 54% of culm bases were infected by *Fusarium* spp. (Tab. 4). Chemical control of the described disease complex contributed to the increase of grain yield by 53.15% = 15.33 dt/ha, and the increase of 1000 grain weight by 22.12% = 7.61 g (Tab. 5).

Table 5. Influence of fungicides on grain yield and 1000 grain weight of winter wheat in 2000–2003

Year	Objects	Yield dt/ha	Increase of yield		1000 grain weight (TGW) g	Increase TGW	
			dt/ha	%		g	%
2000	protected with fungicides	43.79	2.99	107.34	43.08	0.85	102.00
	untreated	40.80	–	100.00	42.23	–	100.00
	LSD (0.05)	1.140			0.974		
2001	protected with fungicides	44.18	15.33	153.15	42.04	5.09	122.12
	untreated	28.85	–	100.00	34.43	–	100.00
	LSD (0.05)	0.583			0.660		
2002	protected with fungicides	61.43	13.48	128.11	39.27	5.09	114.89
	untreated	47.95	–	100.00	34.18	–	100.00
	LSD (0.05)	1.204			1.089		
2003	protected with fungicides	66.37	9.10	115.89	50.36	3.24	106.87
	untreated	57.27	–	100.00	47.12	–	100.00
	LSD (0.05)	1.024			0.699		

Also in the year 2002 a severe leaf infection was recorded. Total infected leaf area amounted to 59.01% with a dominance of brown rust (37.13% of infected leaf area) (Tab. 2). The intensity of eyespot was also high (infection index 18.00), and the number of culm bases infected by *Fusarium* spp. was equal to 36.00%. Chemical control of diseases in that year resulted in the increase of grain yield by 28.11% = 13.48 dt/ha and the increase of 1000 grain weight by 14.89% = 5.05 g (Tab. 5).

The results of experiments performed in years 2000–2003 show that it is not possible to obtain high grain yield of a good quality without chemical control of fungal diseases. This is also confirmed by other authors (Głazek and Jańczak 1998; Jaczewska-Kalicka 1998; Nieróbca 2002, Nelson et al. 1976; Podolska and Sułek 2002 and 2003; Stankowski et al. 2001). In the recent years much attention is being paid to forecasting methods of disease occurrence with the use of meteorological data. The reason for this is a well known fact that the development and severity of fungal diseases is to a high degree dependent on weather conditions and the phase of plant development. For analysis of these relationship computer programs (Decision Support System – DSS) are used. These systems are based on mathematical models of plant disease occurrence and on current meteorological data that allow the exact prediction of danger related to the occurring diseases. The main purpose of these systems is to transmit within a short period of time reliable information on the necessity of performing fungicidal treatments in a given location. The development of these systems is also of a particular importance for integrated plant protection in agricultural practice.

REFERENCES

Arseniuk E. 2002. Postęp w hodowli zbóż. Zboża jakościowe. Poradnik dla producentów. Agro Serwis: 3–9.

Baalbaki R.Z., Copeland L.O. 1997. Seed size, density and protein content effects on field performance of wheat. Seed Science and Techn., 25: 511–521.

Clear R.M., Patrick S.K. 1993. Prevalence of some seedborne fungi on soft white winter wheat seed from Ontario, Canada. Canad. Plant Dis. Survey 73: 143–149.

Gan Y., Stobbe E.H., Moes J. 1992. Relative date of wheat seedling emergence and its impact on grain yield. Crop Science 32: 1275–1281.

Głazek M., Jańczak C. 1998. Znaczenie chorób fuzaryjnych zbóż. Jakość materiału siewnego. Ochrona Roślin nr 3: 20–24.

Jaczewska-Kalicka A. 1998. Risk of damage to winter wheat by *Pseudocercosporella herpotrichoides* (Fron) Deighton, the causal agent of eyespot. J. Plant Protection Res., 38 (2): 109–138.

Korbas M., Ławecki T. 2003. Możliwości ograniczenia fuzariozy kłosów w Polsce i Unii Europejskiej. Prog. Plant. Protection/Post. Ochr. Roślin 43 (1): 200–207.

Nelson L.R., Holmes M.R., Cunfer B.M. 1976. Multiple regression accounting for wheat yield reduction by *Septoria nodorum* and other pathogens. Phytopathology 66: 1375–1379.

Nieróbca A. 2002. Prognozowanie chorób na podstawie bieżących danych meteorologicznych. Pam. Puł., 130: 495–502.

Oleksiak T. 2002. Efekty hodowli pszenicy ozimej. Cz. I. Zmiany potencjału odmian. Biul. IHAR 223/224: 67–75.

Patterson F.L., Shaner G.E., Ohm H.W., Foster J.E. 1990. A historical perspective for the establishment of research goals for wheat improvement. J. Production Agriculture 3: 30–38.

Podolska G., Sułek A. 2002. Główne elementy technologii produkcji decydujące o wysokiej jakości ziarna pszenicy. Pam. Puł., 130: 597–605.

Podolska G., Sułek A. 2003. Jakość ziarna pszenicy w Polsce i Unii Europejskiej. Pam. Puł., 132: 363–369.

Rozbicki J. 2002. Kształtowanie wielkości i jakości plonu zbóż. Produkcja i rynek zbóż. Wyd. „Wieś Jutra" Warszawa. Cz. III: 141–158.

Scott P.R., Hollins T.W. 1974. Effects of eyespot on the yield of winter wheat. Ann. Appl. Biol., 78: 269–279

Shah D., Bergstrom G.C., Ueng P.P. 1995. Initiation of *Septoria nodorum* blotch epidemics in winter wheat by seedborne *Stagonospora nodorum*. Phytopathology 85: 452–457.

Solarski T. 2002. Zboża – przede wszystkim jakość. Zboża jakościowe. Poradnik dla producentów. Agro Serwis Warszawa: 10–11.

Stankowski S., Podolska G., Szypuła G. 2001. Wpływ wybranych sposobów ochrony na jakość ziarna pszenicy ozimej. Biul. IHAR 218: 155–161

POLISH SUMMARY

ZALEŻNOŚĆ PLONOWANIA I JAKOŚCI ZIARNA PSZENICY OZIMEJ OD ROZWOJU CHORÓB GRZYBOWYCH ORAZ WARUNKÓW KLIMATYCZNYCH W LATACH 2000–2003

Dla producentów pszenicy ozimej głównym celem jest uzyskanie wysokiego plonu gwarantującego rentowność. Jednak o opłacalności jej uprawy decyduje w dużym stopniu wysoka jakość ziarna dająca szansę uzyskania wyższej ceny sprzedaży. Na jakość ziarna wpływa wiele czynników. W przedstawionej pracy badano wpływ warunków klimatycznych oraz nasilenia rozwoju chorób grzybowych występujących na liściach, kłosach i podstawie źdźbeł pszenicy ozimej. Czteroletnie doświadczenia ścisłe prowadzono w Rolniczym Zakładzie Doświadczalnym SGGW Chylice woj. mazowieckie na pszenicy ozimej odm. Kobra i Mikon. Zabiegi fungicydowe wykonywano dwukrotnie: w fazie strzelania w źdźbło (GS 30) i w fazie początku kłoszenia pszenicy ozimej (GS 51) stosując najnowsze preparaty przeznaczone do zwalczania kompleksu chorób grzybowych pszenicy ozimej. Warunki pogodowe w badanych latach były zróżnicowane. Odnosi się to szczególnie do okresów intensywnego wzrostu i dojrzewania pszenicy ozimej (kwiecień–lipiec), w których niedobór opadów wpływał znacząco zarówno na rozwój chorób grzybowych, jak i na jakość ziarna. W 2000 roku wystąpiła dotkliwa susza, w latach 2001 i 2002 warunki pogodowe były zbliżone do normy, a w 2003 roku wystąpił w tym okresie pewien niedobór opadów. Miało to wpływ na występowanie i nasilenie rozwoju chorób grzybowych oraz na wielkość i jakość plonu ziarna. W latach 2000–2003 plon ziarna pszenicy ozimej w kombinacjach chronionych fungicydami był wyższy średnio o 26,12% (w przedziale od 7,34% do 53,15%) a masa 1000 ziaren (MTZ) wyższa średnio o 11,47% (w przedziale od 2,00% do 22,12%).

Book Review

Dolzhenko V.I. 2004. Vrednye Sharanchovye: Biologiya, Sredstva i Tekhnologiya Borby [Noxious Locusts: Biology, Means and Technology of Control]. Russian Academy of Agricultural Sciences, All-Russian Institute of Plant Protection, and Innovation Center of Plant Protection. Sankt Petersburg, 215 pp. ISBN 5-93717-021-0. (In Russian)

Locusts are worldwide serious pests and preventive and intensive control measures are needed to avoid economic losses in various crops: cereals, vegetables, melons, meadows and pastures. In Russian Federation in 2000 control measures against locusts were performed on an area of over 2 million hectares. Also in several other European countries e.g. in Spain preventive and control measures against locusts are needed every year. Therefore the Russian experience presented in the reviewed books should be of interest to a wide circles of entomologists and plant protection specialists.

The reviewed book contains the following chapters: Chap. 1 “General information on locusts” (p. 5–11); Chap. 2 “Gregarious locusts” (p. 12–20); Chap. 3 “Non-gregarious locusts” (p. 21–26); Chap. 4 “Methods of locusts survey and categories of evaluation” (p. 27–35); Chap. 5 “Planning of control measures” (p. 36–38); Chap. 6 “Methods of locust control” (p. 39–52); Chap. 7 “Biological grounds for use of chemical insecticides” (p. 53–171); Chap. 8 “Preventive strategies of control of locusts populations (p. 177–179); Chap. 9 “Modern control technologies” (p. 180–185); Chap. 10 “Economic effectiveness of barrier treatments” (p. 186); Chap. 11 “Equipment for locust control” (p. 187–188); Chap. 12 “Complex of treatments for locust control” (p. 188–189). In addition to the above mentioned chapters the book contains: “Conclusions” (p. 190–191), “References” (p. 192–197) and “Appendices 1–3” (p.198–215).

The book is very valuable as it contains information on biology, ecology and control of the following locust species: *Locusta migratoria migratoria* L., *L. migratoria rossica* Uv. et Zol., *Calliptamus italicus* L., *Dociostaurus maroccanus* L., *Dociostaurus kraussi* Ing., *Aeropus sibiricus* L., *Stauroderus scalaris* F.-W., *Pararcyptera microptera* F.-W., *Arcyptera fusca* Pall., *Oedaleus decorus* Germ., *Chorthippus albmarginatus* De Geer, *Omocestus* spp., and *Stenobothrus* spp.

I recommend this book to entomologists and plant protection specialists.

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