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PECULIARITIES OF WHEAT LEAF DISEASE DISTRIBUTION IN LATVIA

Biruta Bankina, Inta Jakobija, Gunita Bimšteine

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Winter wheat diseases are one of the main risk factors which influence productivity and quality of wheat production. The aim of this investigation was to summarize and analyze disease registration data obtained by specialists of the State Plant Protection Service during 1995-2002. Analysis of disease dynamic curves allowed determining the most crucial points in disease development and helped to build up the disease control system. Observations were done every weak starting from tillering till milk ripening in wheat production fields in all regions of Latvia. Mildew, tan spot, septoria leaf blotch, as well as brown rust and yellow rust are the most important wheat leaf diseases in Latvia. Occurrence of mildew (caused by *Blumeria graminis*) was very high every year – on average, the disease was found in 83% of the inspected fields. Severity of mildew was low – at the flowering stage of wheat it did not reach 5% in 67% of the fields. Septoria leaf blotch (caused by *Septoria tritici*) was found in 86 – 100% (on average – 97%) of all inspected fields, and only in 25% of the fields severity of the disease did not reach 5%. The most crucial period of disease development was the time after flowering. Occurrence of tan spot (caused by *Pyrenophora tritici-repentis*) sharply increased during the time of observations (from 5% in 1995 till 100% in 2002). Yellow rust (caused by *Puccinia striiformis*) was observed only in 32% of fields, and brown rust (caused by *Puccinia tritici*) was observed sporadically. Knowledge about the disease life cycle and severity allows developing an effective and sustainable control system of wheat diseases and avoid unnecessary fungicide application.

Key words: *Pyrenophora tritici-repentis*, *Septoria tritici*, *Blumeria graminis*, rate of infection

Institute of Soil and Plant Sciences, Latvia University of Agriculture, Liela Street 2, Jelgava, LV 3001, Latvia, Biruta.Bankina@llu.lv

State Plant Protection Service, Lielvardes Street 36-38, Riga, LV 1006,Latvia, Inta.Jakobija@vaad.gov.lv

INTRODUCTION

Winter wheat is one of the most important and economically beneficial crops in Latvia. Diseases, including leaf diseases, are a significant risk factor which influences the quantity and quality of grain production under conditions of Latvia. The spectrum and harmfulness of diseases has changed over the years (Bankina 2005). Distribution of pathogens is a complex phenomenon – it is set by host distribution and susceptibility levels, crop management and environment (Shaw,

Osborne 2011). Knowledge about regularity of disease emergence may play a significant role in building up an effective and sustainable control system of wheat diseases. During 15 days (from BBCH 59 till BBCH 85), severity of diseases increases by 50-150% depending on the year, cultivar, and crop rotation (Wyczling et al. 2010).

Intensive applications of different fungicides are common in agronomic practice. Unnecessary sprayings have been recognized in many cases. It is considered that if the disease severity is higher than 5%, it seriously influences the yield (Te Beest et al. 2008). Evaluation of the situation on each field and forecasts are necessary to choose optimal control strategy of diseases.

Mildew, tan spot, and septoria leaf blotch have been the most widespread and harmful diseases in Latvia during the last twenty years. Yellow and brown rust are observed, but they are not significant in most cases. Yield losses depend on the time of symptoms appearance and severity of diseases (Priekule & Bankina 2004).

Mildew, caused by *Blumeria graminis*, is one of the most observed wheat diseases in the world, also in North and Central Europe (Miedaner, Flath 2007). Powdery mildew has occurred on average on 50% of the wheat in the United Kingdom (Te Beest et al. 2008). The important role of mildew has been observed also in Lithuania and Estonia (Koppel et al. 2004, Liatukas & Ruzgas 2005). Symptoms of mildew appear in all stages of disease development – from the stage of tillering till ripening. Prevalence of this disease depends on the meteorological conditions and agronomical practice. Development of mildew does not depend only on the initial infection source, because the rate of conidia production per colony can be very high, and multiple generations are characteristic for the development of mildew (Rouse et al. 1981).

Septoria leaf blotch, caused by *Septoria tritici*, teleomorph *Mycosphaerella graminicola,* is one of the most widespread wheat diseases all over the world, also in the United Kingdom, but its severity differs between the years and localities. In 1985-1996, percentage of fields above thresholds of septoria severity ranged from 1.3 to 35.3% in UK. Development of the disease was dependent on varieties, agronomic factors and meteorological conditions, because spores of the pathogen were dispersed by rain splash (Gladder et al. 2001). The newly sown crops are infected in autumn by spores from the remains of the previous year crop. However, yield losses are related to severity of the disease on the flag leaves (Shaw & Royle 1993).

Tan spot, caused by *Pyrenophora tritici-repentis* (anamorph *Drechslera tritici-repentis*, was first identified in the United States in the 1940s, and since then its incidence and severity have increased. Now it has become more important wheat disease over the world, especially in the regions with intensive wheat management (Wolf et al. 1998). In Latvia and Lithuania, tan spot was noticed and identified for the first time in the first half of the 1990s. Since then the spread of the disease has rapidly increased with increase in wheat percentage in a crop rotation and enlargement of the area under minimum tillage (Bankina 2005, Ronis et al. 2009). Severity of the disease fluctuates depending on the year and the variety reaching nearly 70% in Lithuania (Ronis & Semaskiene 2006). The primary infection of tan spot is initiated by ascospores from wheat straw debris. The release of ascospores starts in spring and can continue throughout all the vegetation season under conditions of Latvia; conidia develop on the necrotic lesions and increase distribution of the disease (Bankina & Priekule 2011). In Latvia, the time of the appearance of the first tan spot symptoms depends on meteorological conditions and varieties – from stem elongation (DC 32–34) till flowering (DC 65–69). According to findings of Wegulo et al., tan spot severity increases exponentially only after wheat flowering till milk ripeness (Wegulo et al. 2009). In Lithuania, in the years 2004 and 2005, a rapid increase in the disease severity was observed only during flowering, but in 2003 – only during ripeness (Ronis& Semaskiene 2006).

Stripe (yellow) rust, caused by *Puccinia striiformis f. sp. tritici*, is one of the most potentially

destructive wheat diseases, but epidemics of this disease emerge sporadically. Yellow rust has been observed only in 8% of wheat fields in the UK (Te Beest et al. 2008). A rapid disease increase can occur early in summer (start of May) in favorable conditions (high humidity, rainfall or dew, and optimal temperatures of 10-15°C), but temperature higher than 23°C stops development of yellow rust (Te Beest et al. 2008). The disease development and subsequent yield losses depend on varieties and dominated races of *P. striiformis* (Milus et al. 2009). Emergence of stripe rust epidemic is related to the expression of new more virulent genes of the pathogen (Welling 2011).

Development of **brown rust,** caused by *Puccinia triticina*, depends on the year and the variety (Wyczling et al. 2010). Brown rust is not an economically important disease in the moderate climate zone, but the situation can change depending on the changes in the climate, the emergence of new pathotypes of *P. triticina*, and changes in varieties resistance (Chakraborty et al. 2011).

The application of mathematical techniques for describing plant disease epidemics, as well as the development and different peculiarities of disease progress was introduced by Van der Plank in 1963 (Van der Plank 1963). Disease progress curves (DPC) show the epidemic dynamics over time. Analysis of disease dynamic curves allows determining the most crucial points in disease development and helps to build up the disease control system. Apparent infection rate is a more applicable measure of the disease increase. Changes in the infection rates during the vegetation period or depending on crop development stages can help to recognize more critical periods of disease development (Gregory et al. 1981).

The aim of this investigation is to summarize and analyze data about diseases development in Latvia during 1995-2002.

METHODS AND MATERIALS

The data analyzed in this paper were obtained by specialists of the State Plant Protection Service during 1995-2002.

The history of establishment and development of this service is long and complicated. The first station was founded in 1913. The present State Plant Protection Service (VAAD) was established pursuant to the Plant Protection Law, adopted by the Parliament *(Saeima)* on 17 December 1988, as a state institution supervised by the Ministry of Agriculture. The Service performs official control and surveillance in the field of free movement of plant protection products, fertilizers, plants and plant products, plant varieties, seed and planting material. One of the VAAD tasks is monitoring and informing the producers and society about diseases and other harmful organisms.

The same methods were used during regular observations in 1995-2002. Unfortunately, after this period, the number of observations was strongly diminished, wherewith methods were changed sharply and data are not comparable. Observations of winter wheat diseases were done every weak starting from tillering till ripening in wheat production fields across all regions of Latvia – alltogether 139 fields were inspected.

Occurrence, incidence and severity of wheat leaf diseases were determined. Incidence of disease means the proportions of infected plants, severity – the amount of tissue damaged. Incidence is expressed as percents, but severity – as percents or special descriptive keys (Gaunt 1991).

Disease progress curves (DPC) were constructed, and apparent rates of infection were computed according to Gregory et al. (1981). Standard deviation and coefficient of determination (R^2) were calculated by Excel MS tools.

RESULTS

The occurrence of mildew was high during the whole period of observations and fluctuated from 50% to 100% (on average – 84%), depending on the year, location and wheat variety (Fig. 1).

Average severity of mildew was low and did

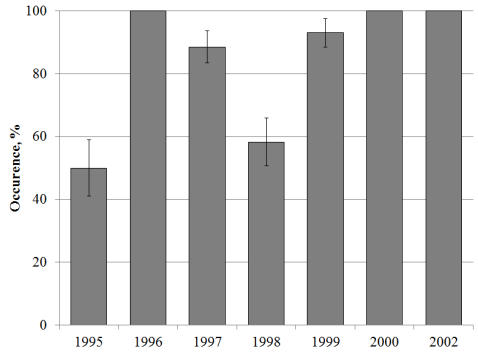

Fig. 1. Occurrence of mildew during 1995-2002 in Latvia.

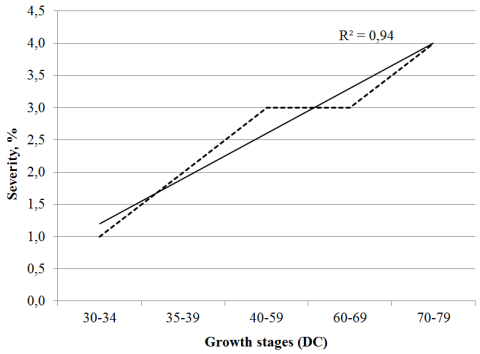

Fig. 2. Dynamics of mildew development during the vegetation season (average data).

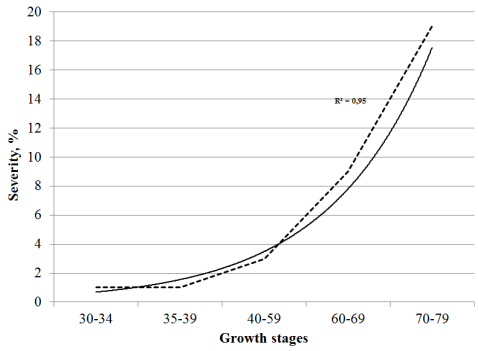

Fig. 3. Development of septoria leaf blotch during 1995-2002 in Latvia.

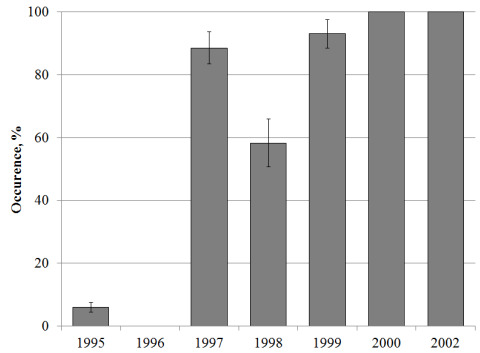

Fig. 4. Occurrence of tan spot during the observations.

not reach 5% in 87% of inspected fields. DPC demonstrated progress of the disease. The first symptoms were observed during stem elongation, and the disease continued to develop slowly throughout all vegetation season (Fig. 2). Coefficient of determination (< 90) confirmed progress of mildew as a linear trend during the vegetation.

Occurrence of septoria leaf blotch and glume blotch on the leaves was very high – 86 – 100% (on average – 97%), and significant fluctuations were not observed. First symptoms of septoria leaf blotch were observed on the oldest leaves at the stage of tillering in autumn. DPC showed the typical peculiarities of disease development: gradual and slow increase of severity from stem elongation till flowering and sharp progress after flowering (Fig. 3). Development of septoria blotch can be expressed as an exponential increase during the vegetation.

Occurrence of tan spot (caused by *Pyrenophora tritici-repentis*) sharply increased during the observations (from 6% in 1995 to 100% in 2002). The first symptoms of tan spot were observed during stem elongation. Shape of tan spot DPC showed exponential increase of tan spot severity after flowering (Fig. 5). Tendencies of tan spot development were the same as for septoria leaf blotch.

Yellow rust (caused by *Puccinia striiformis*) was found only in 20-50% (on average – 33%) of inspected fields. The first symptoms of yellow rust were observed at different growth stages (Fig. 6). Brown rust (caused by *Puccinia tritici*) was observed sporadically and was not found every year.

First symptoms of the disease were observed late at the vegetation season (except 1996), when rust was found at the stage of stem elongation (Fig. 6).

Peculiarities of the development of different wheat diseases are shown by apparent rates of

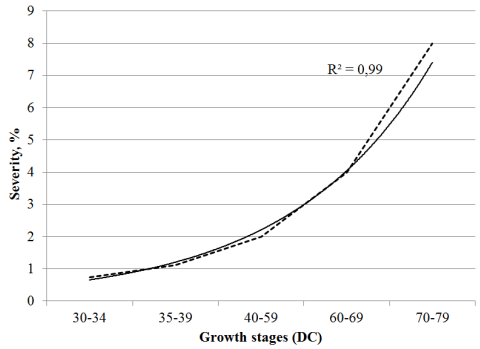

Fig. 5. Dynamics of tan spot development during 1995-2002 in Latvia.

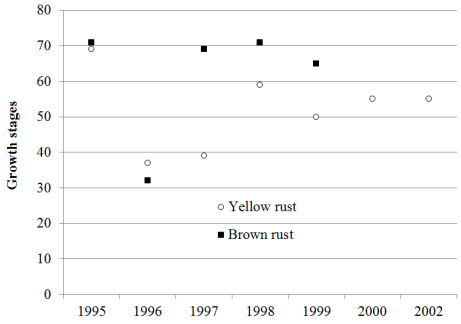

Fig. 6. The time (growth stage) of appearance of the first symptoms of yellow rust and brown rust.

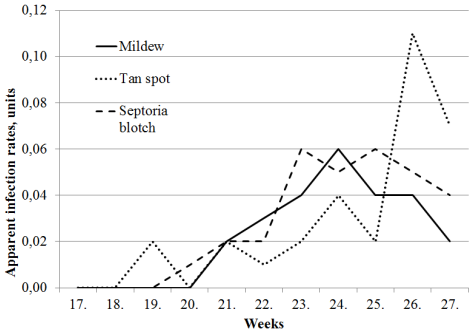

Fig. 7. Apparent infection rates of wheat leaf diseases.

infection in Fig. 7.

Mildew infection rate slowly increased during stem elongation till flowering, after which it sharply decreased. The rate of septoria blotch infection was not high, but during vegetation it increased. A high infection rate was observed at the time of flowering (approximately at the 25th week), but during ripening – decreased. Though increase in the rate of tan spot infection was slow and gradual, at the time of ripening the disease progressed very rapidly (Fig. 7).

DISCUSSION

High occurrence of mildew has been observed also in other countries (Ruzga et al. 2002, Miedaner & Flath 2007), which has not been related to harmfulness of the disease. A relatively low level of powdery mildew at the stage of stem booting and at the stage of flowering has been observed in Poland (Wyczling et al. 2010) and southern Sweden (Wiik & Ewaldz 2009). Severity and harmfulness of mildew depend on the variety and density of wheat. High relative humidity of air promotes release and germination of conidia. *B. graminis* is an obligate parasite which is the reason of decrease in mildew development after flowering – during wheat leaf senescence. Moreover, necroses, caused by other pathogens limit distribution of mildew. In most cases, mildew is not a harmful disease, but it is necessary to evaluate the risk of disease spreading at the stage of stem elongation under conditions of Latvia.

Low incidence and especially severity of **rusts** (caused by *P. striiformis* and *P. tritici*) were observed during our observations. Similar results have been reported also in Sweden: incidence has been relatively low during the last twenty years and has not reached 20% (Wiik & Ewaldz 2009). Although yellow rust is a potentially harmful disease, its late appearance (at the time of flowering and later) does not cause significant yield losses. The situation could be changed, because newly emerging, aggressive and high temperature-tolerant populations of *P. striiformis* have been found (Welling 2011).

Leaf spot has been recognized as a serious problem in Poland – severity of leaf spots (caused by *P. tritici-repentis*, *S. nodorum* and other pathogens together) reaches about 70% (Wyczling et al. 2010).

Septoria leaf blotch and glume blotch (caused

by *Septoria tritici* and *Stagonospora nodorum*) are widely distributed in Latvia and also in other countries (Scharen 1999, Kolomiets 1999, Ruzgas et al. 2002, Mincu 1999, Ronis et al. 2009, Koppel et al. 2003). In Latvia, a rapid development of septoria blotch has been observed after flowering. Similar tendencies of leaf blotch disease progress only after flowering have been observed also in other investigations, for example, in Poland. During GS 45-55, incidence of wheat leaf blotch has increased only slightly, but in later stages of plant development – much faster (Wiik & Ewaldz 2009). The main source of septoria leaf blotch infection is the remains of wheat and live plants which were infected in autumn. Exponential growth of disease severity could be explained by the development of several generations of conidia and asco spores. Asco spores as the main source of primary infection and also of additional infection material during the vegetation season have been reported all over Europe (Eriksen & Munk 2003). Intensive development of the disease during ripening could be explained by senescence of leaves and repeated cycles of the disease development caused by conidia. There are no data about the presence of teleomorph *Mycosphaerella graminis* in Latvia.

In Latvia for the first time tan spot was noticed and identified in the first half of the 1990s. The rapid spread of the disease is linked with increase of wheat proportion in the sowing structure, the change in the varietal composition, and the expansion of the area under minimum tillage, which allows the inoculum to build up on wheat stubble over time (Bankina 2000). In recent years, tan spot has become a potentially destructive disease of wheat also in Lithuania (Ronis et al. 2009). High prevalence of tan spot has been confirmed in several investigations in Latvia, where occurrence of disease reached 96% (Bankina 2005, Bankina & Priekule 2005). Different values of the apparent rate of tan spot infection have been determined in the investigations, but all researchers have confirmed a sharp increase in the infection rate during ripening (Bankina & Priekule 2011). These results have been related to spreading of asco spores during the vegetation and increase in the number of older wheat leaves susceptible to tan spot. There are data in the literature about antagonism between *S. tritici* and *P. tritici-repentis*. This phenomenon might explain the different trend lines of the development of these diseases at the latest stages of ripening (Pedersen & Hughes 1992).

The understanding of peculiarities of disease development and most crucial points of disease spreading allow building up a biologically- and economically-based protection system against wheat diseases under conditions of Latvia.

CONCLUSIONS

Tan spot, septoria leaf blotch, and mildew are the most important wheat leaf diseases in Latvia. Brown rust and yellow rust were observed sporadically.

Occurrence of mildew fluctuated depending on the year. The most rapid disease development occurred during stem elongation till flowering.

Prevalence of septoria leaf blotch was determined each year, and the crucial point of disease development was the stage of heading and flowering.

Tan spot has become the most important wheat leaf disease during the last years in Latvia. Its most rapid development was observed at the time of ripening.

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