CROP ROTATION – THE MAIN FACTOR INFLUENCING THE DEVELOPMENT OF WHEAT LEAF BLOTCH

Biruta BANKINA[1], Gunita BIMŠTEINE[1], Antons RUŽA[2], Dzintra KREITA[3], Merabs KATAMADZE[3], Līga PAURA[4]

[1]Latvia University of Agriculture, Institute of Soil and Plant Sciences

[2]Latvia University of Agriculture, Institute of Agrobiotechnology

[3]Latvia University of Agriculture, Study and Research Farm "Peterlauki"

[4]Latvia University of Agriculture, Department of Control Systems

2 Liela street, Jelgava, Latvia, LV-3001;

Email: biruta.bankina@llu.lv

Abstract. *Lack of crop rotation increases the risk of wheat leaf blotch (caused by Pyrenophora tritici-repentis and Zymoseptoria tritici) development. The aim of the presented study is to clarify the importance of the wheat pre-crop and pre-pre-crop on the development of wheat leaf blotches. A long-term field experiment was established at the Research and Training Farm "Peterlauki" of the Latvia University of Agriculture. The incidence and severity of tan spot were assessed for the whole plant until BBCH 31, for the three upper leaves until BBCH 32-69, and for the two upper leaves until later stages. The obtained results (2012-2014) were categorised according to different crop rotations: 1) pre-crop of wheat (A – wheat; B – alternative crop); and 2) pre-pre-crop of wheat (C – wheat; D – alternative crop). The total impact of disease during the vegetation season was evaluated by calculating the area under the disease progress curve (AUDPC). A rapid development of wheat leaf blotches was observed at the time of flowering except for continuous wheat, where the disease progress started significantly earlier – at the time of booting. Wheat as a previous crop and a pre-previous crop significantly increased the severity of tan spot during the whole vegetation season. The influence of the scheme of crop rotation was less important for the development of Septoria leaf blotch; however, a more-than-a-year break between wheat crops decreased the infection level.*

Key words: *Pyrenophora tritici-repentis, Zymoseptoria tritici, pre-crop, pre-pre-crop.*

INTRODUCTION

Wheat production is one of the most important and profitable branches of crop production in Latvia. The consequence of this situation is the increasing proportion of wheat in the structure of sowings. Lack of classical crop rotation increases the risk of the development of harmful organisms, including the causal agents of diseases. Wheat leaf blotches, especially tan spot (caused by *Pyrenophora tritici-repentis*) and Septoria leaf blotch (caused by *Zymoseptoria tritici*), are the most harmful and widespread wheat diseases in Latvia [1]. Tan spot survives in infected wheat residues; after the necrotrophic phase, pseudotechia develop and asco spores are spread by wind. Therefore, crop rotation has been considered as the main factor influencing the progress of this disease [2],[3]. The life cycle of Septoria blotch is different, it is a splash-borne disease, and therefore the main risk factor of disease development is meteorological conditions, specifically – the number of rainy days [4]; however, agrotechnical measures also influence the severity of this disease. Both causal agents of wheat leaf blotches survive mainly in the residues of wheat – for this reason, the amount of primary inoculums depends on the amount of residues from the previous years. Decomposition of residues is a complex and complicated process; it can be influenced by the content of organic matter in soil, the microbiological activity of soil, the spectrum of soil microorganisms, and also meteorological conditions. Empirical observations show that one year is not sufficient time for a complete decomposition of straw and pseudotechia are found also after two seasons of vegetation. Many different investigations have been conducted all over the world regarding crop rotation as an important control measure of wheat diseases, but the results obtained are inconsistent and the importance of the pre-pre crop is not completely evaluated.

The aim of the presented paper is to clarify the importance of the wheat pre-crop and pre-pre-crop on the development of wheat leaf blotches.

MATERIALS AND METHODS

A long-term field experiment was established at the Research and Training Farm "Peterlauki" of the Latvia University of Agriculture in 2008. The trial conditions were very similar to actual crop production conditions; the total plot area was 6 ha, and the area for each treatment was 0.25 ha. Altogether, 12 plots of winter wheat were surveyed each year.

All agronomic measures were applied uniformly, according to the requirements of agronomic practice in Central Latvia in the vegetation season. Foliar fungicide (epoxiconazole 84 g L^{-1} and fenpropimorph 250 g L^{-1}) 1.5 L ha-1 was sprayed at the time of heading in all treatments.

The incidence and severity of tan spot and Septoria leaf blotch were assessed for the whole plant until BBCH 31, for the three upper leaves until BBCH 32-69, and for the two upper leaves until later stages.

The obtained results (2012-2014) were categorised according to different crop rotations: 1) pre-crop of wheat (A – wheat; B – alternative crop); and 2) pre-pre-crop of wheat (C – wheat; D – alternative crop).

The total impact of disease during the vegetation season was evaluated by calculating the area under the disease progress curve (AUDPC) according to the formula:

$$AUDPC = \sum_{n-1} \left[\frac{X_1 + X_2}{2} * (t_1 - t_2)\right],$$

where AUDPC – area under the disease progress curve; n – number of assessments; x – severity of disease at the time of assessment; t_1-t_2 – period of time between assessments.

For statistical analyses of the total impact of the diseases, expressed as the value of AUDPC, a three-factor ANOVA was performed, which included the year factor and the crop and pre-crop factors. The crop and pre-crop factors were analysed in different ways: two factors separately, and as two-factor combinations. Factors "crop and pre-crop rotations" were combined into four groups: wheat after wheat, wheat after other pre-crop, other crop after wheat, and other crop after other pre-crop.

The factor was considered statistically significant when $p<0.05$.

RESULTS AND DISCUSSION

The first symptoms of wheat leaf blotches were observed at the time of tillering and stem elongation; during the stem booting, severity of both diseases decreased because the young leaves were not infected. The severity of tan spot was substantially more expressed, especially in continuous wheat sowings (Fig. 1).

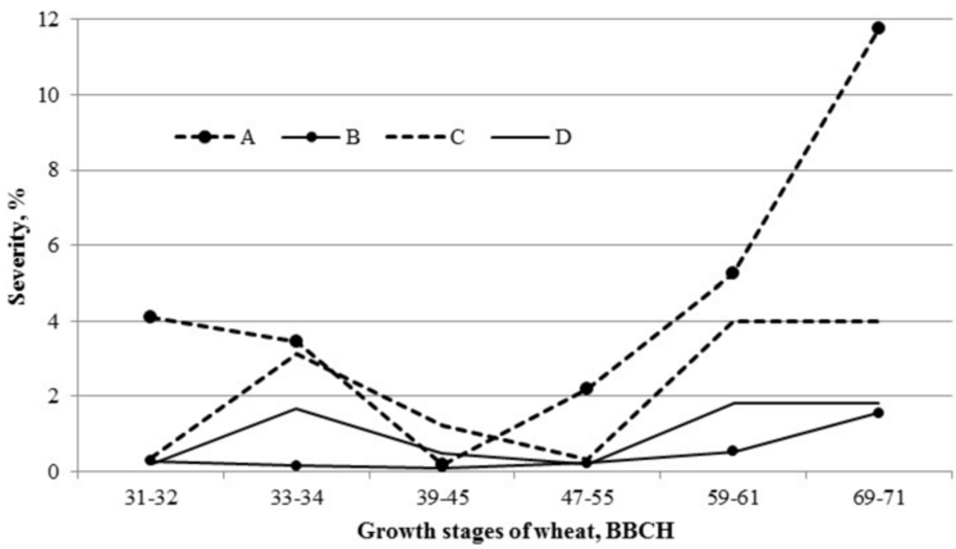

Figure 1. **Dynamics of the development of wheat leaf blotches during vegetation seasons:** A – tan spot in continuous wheat sowings; B – tan spot in the fields after alternative crop; C – Septoria leaf blotch in continuous wheat sowings; D – Septoria leaf blotch in the fields after alternative crop.

A rapid development of wheat leaf blotches was observed at the time of flowering, except for the variant A (tan spot in continuous wheat sowings), when the progress of the disease started significantly earlier – at the time of booting. Similar tendencies of tan spot development during the season of vegetation have been observed also in other experiments in Latvia and Lithuania [1],[5] – the time after winter wheat flowering has been noted as the crucial period of tan spot development.

The values of AUDPC characterize the impact of disease through the whole vegetation season. The development of Septoria leaf blotch was affected by year, but differences in the values of tan spot AUDPC were not statistically significant because variances among the treatments were more considerable (Fig. 2).

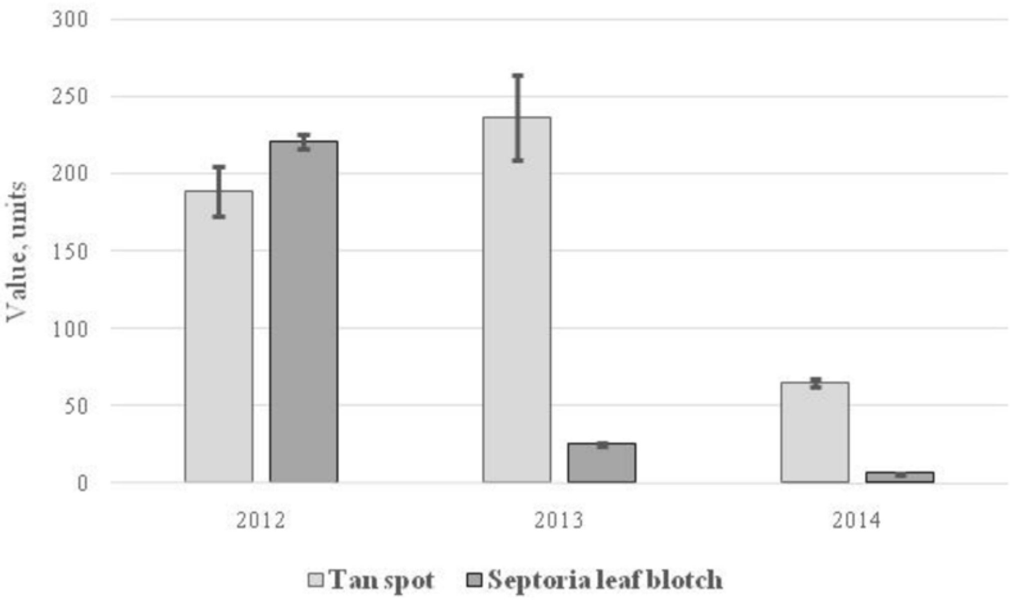

Figure 2. **Development of wheat leaf blotches depending on year.**

The obtained results confirmed the previous observations: distribution of Septoria leaf blotch is closely related to meteorological conditions, but tan spot can progress independently of meteorological conditions of a year [4].

The previous crop and the pre-previous crop significantly influenced the value of tan spot AUDPC ($p<0.05$ and $p<0.1$, accordingly) – see Fig. 3.

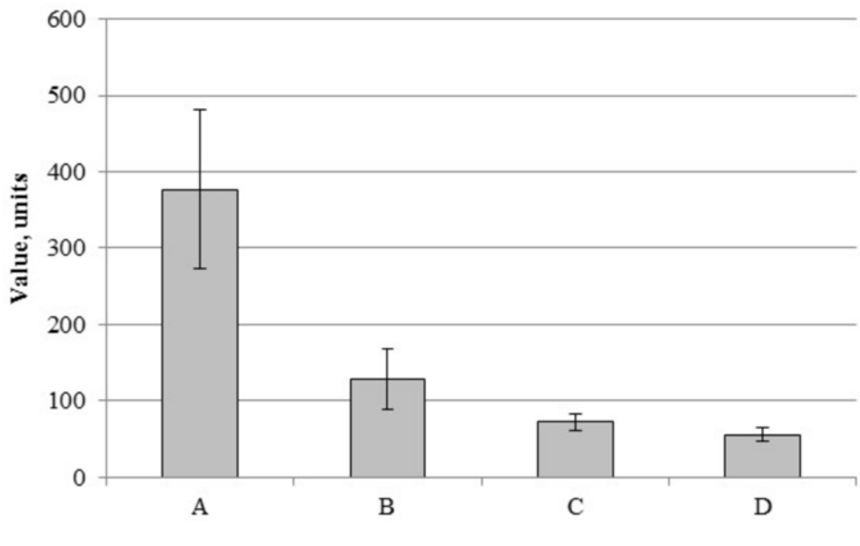

Figure 3. **Development of tan spot, caused by *Pyrenophora tritici-repentis*, depending on the pre-crop and the pre-pre-crop,** where A – wheat after wheat, also the pre-pre-crop was wheat; B – wheat after wheat, but the pre-pre-crop was alternative; C – wheat after the alternative crop, but the pre-pre-crop was wheat; D – wheat after the alternative crop, also the pre-pre-crop was alternative.

Resowing of wheat allows wheat residues to accumulate in the field, which provides favourable conditions for the infection and further development of *P. tritici-repentis*. The highest value of tan spot AUDPC was detected in the fields where wheat had been sown at least for two years in succession. A break of one year between the wheat sowings was not sufficient because also in this variant where wheat was the pre-crop, the level of the disease was higher.

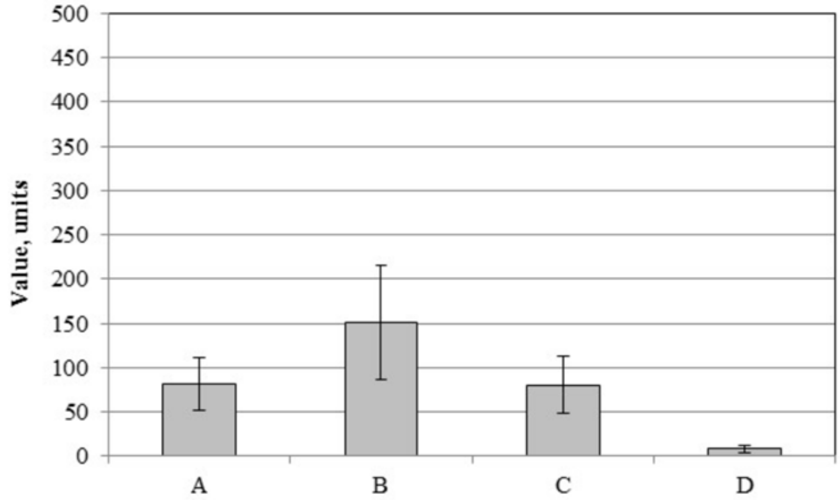

Figure 4. **Development of Septoria leaf blotch, caused by *Zymoseptoria tritici*, depending on the pre-crop and the pre-pre-crop,** where A – wheat after wheat, also the pre-pre-crop was wheat; B – wheat after wheat, but the pre-pre-crop was alternative; C – wheat after the alternative crop, but the pre-pre-crop was wheat; D – wheat after the alternative crop, also the pre-pre-crop was alternative.

The effect of crop rotation scheme on the development of Septoria leaf blotch was statistically insignificant (Fig. 4); however, a more-than-a-year break between wheat sowings essentially decreased the development of Septoria leaf blotch.
Our findings confirm the results obtained previously (Sawinska et al. (2006) – Septoria leaf blotch development varied in successive years [6],[7].

CONCLUSIONS

The scheme of crop rotation significantly influenced the development of wheat tan spot. The severity of tan spot was essentially higher in fields where the pre-crop of wheat was wheat, as well as in fields where the break in wheat sowings was only one year.

The severity of Septoria leaf blotch was slightly influenced by crop rotation, and the level of the disease was significantly lower in fields where the break between wheat sowings was more than one year.

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