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Effect of perennial grasses ploughed in as green manure on the occurence of net blotch in spring barley

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Abstract. Experiments were carried out in the Vėžaičiai Branch of the Lithuanian Institute of Agriculture (West Lithuania) in 2005–2007. The aim of this research was to assess the impact of using perennial legumes (red and white clover, lucerne) and timothy as green manure in crop rotation on the occurence of net blotch disease (causal agent *Drechslera teres* (Sacc.) Shoem.) in spring barley. Preceding crops of spring barley were winter triticale and winter rye (perennial grasses were preceding crops of these winter cereals). The yearly occurence of net blotch disease was high: incidence was about 70.00–100.00% severity; at the spring barley booting stage (BBCH 37-39) – from 4.45 to 12.25%, at milk maturity stage (BBCH 73-75) – 43.75–70.95%. The variously-managed perennial grasses in the crop rotation had a significant effect on the occurence of net blotch: the spring barley grown after timothy was 1.1–1.5 times less affected in 2005 and 2007, compared to the spring barley grown after red and white clovers, and about 1.2 times less affected grown after lucerne, compared with spring barley grown after other grasses in 2006.

Key words: perennial grasses, *Drechslera teres,* net blotch, disease, incidence, severity, spring barley

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an intensively cultivated cereal crop worldwide and is one of the most widely grown cereal crops in Lithuania: the total area of spring barley in 2007 was 365.3 thousand ha (36.3% of all cereals). The most important and widespread disease of barley is net blotch, caused by phytopathogenic fungus *Drechslera teres* (Sacc) Schoemaker; teleomorphic stage: *Pyrenophora teres* Drechs., (syn. *Helminthosporium teres* Sacc.) Financial losses to this foliar pathogen result from yield reduction, ranging from 15-35% (Khan, 1987). Heavy pressure of this disease was recorded in 2006 and especially in 2007. Net blotch occurred in the spring barley crop most severely during the booting stage – BBCH 30-33 (Semaškienė & Statkevičiūtė, 2008). Many authors indicate that the incidence of fungal diseases of spring barley is determined by the weather conditions (net blotch requires high humidity and wet weather to infect a plant, but develops faster at higher temperatures), imbalanced mineral fertilisation, crop species and variety, soil preparation, preceding crop, weed infestation, abundance of pests, and luxuriance of the crop stand (Skou & Haahr, 2008; Robinson & Jalli, 1999). Some researchers' data suggest that more abundant fertilisation promotes the spread of some foliar diseases (Lisova et al., 1996). Crop rotation, plowing-in old straw and stubble, and seed treatment will aid in prevention of this disease. Cheap and high quality green manure is an important element in crop alternation in specialised cereal crop rotations. The use of green manure tends to reduce weed, disease and pest incidence. But it was established that severity of foliar diseases was highest and yield lowest when barley was grown on its own residue compared with barley rotation. Intercropping of barley with suitable alternatives, such as triticale or oats, may also result in reduced foliar disease levels (Tripolskaja, 2005). The preliminary results from the *Drechslera teres* population studies indicate that both the crop rotation and the cultivation method have a significant effect on the structure of this pathogen population (Jalli, 2008). A survey of some fields of spring barley in West Sussex showed that the extent and severity of net blotch in the crop depended on the amount of stubble debris from the preceding barley crop lying on the soil surface (Evans, 2007).

The aim of this research was to establish the impact of using perennial grasses as green manure in crop rotation on the occurence of net blotch in spring barley.

MATERIALS AND METHODS

Experimental layout

The work was performed in 2005–2007 at the Vėžaičiai Branch of the Lithuanian Institute of Agriculture, situated in Western Lithuania. Two experiments were set up in 2002 and 2003. The treatments were replicated four times and were arranged randomly. The soil of the experimental site was *Albi-Edohypogleyic Luvisol*, light loam on medium heavy loam. The agrochemical characteristic of the plough layer before trial establishment: pH_{KCl} 5.80–6.20, humus 1.56–2.30%, available P_2O_5 84–207 mg kg^{-1}, available K_2O 94–134 mg kg^{-1} (A-L method). The crop rotation was: 1) perennial grasses, 2) winter cereals (triticale 'Tevo' and rye 'Rūkai'), 3) spring barley 'Ūla'. The winter cereals were grown after differently managed preceding crops: 1. Red clover 'Vyliai' – 1^{st} crop for forage, aftermath ploughed in; 2. Red clover 'Vyliai' – cut twice, residues ploughed in; 3. White clover 'Sūduviai' – 1st crop for forage, aftermath ploughed in; 4. White clover 'Sūduviai' – cut twice, residues ploughed in; 5. Common lucerne 'Birutė' – 1st crop for forage, aftermath ploughed in; 6. Common lucerne 'Birutė' – cut twice, residues ploughed in; 7. Timothy 'Gintaras II' – cut twice, residues ploughed in. Spring barley was sown at a seed rate of 200 kg ha^{-1} in the third decade of April. Barley stand density varied from 369 - 629 plants m^{-2}.

Plant green mass was chopped and shallowly incorporated during the phytocenosis flourishing period, and after two weeks was deeply ploughed in. No mineral fertilisers and plant protection products were used. The amount of nutrients incorporated into the soil with plant residues and with aftermath were next: with red clover P_2O_5 37–50 kg ha^{-1}, K_2O 86–138 kg ha^{-1}, total N 145–185 kg ha^{-1}; with white clover P_2O_5 15–33 kg ha^{-1}, K_2O 38–95 kg ha^{-1}, total N 69–126 kg ha^{-1}; with common lucerne P_2O_5 74 kg ha^{-1}, K_2O 200 kg ha^{-1}, total N 304 kg ha^{-1}; with timothy: P_2O_5 18 kg ha^{-1}, K_2O 40 kg ha^{-1} (Skuodienė & Daugėlienė, 2008).

Disease assessment

Foliar disease assessments on spring barley were carried out in 2005–2007 at booting (BBCH 37-39) and at milk maturity (BBCH 73-75) stages. In each treatment under assessment 10 places were randomly chosen and three normally developed stems were taken per place. Three top green leaves were assessed per stem.

Disease incidence, i.e. per cent of disease-affected leaves (P) was calculated according to the following formula:

$$P = \frac{n}{N} \cdot 100,$$ where n – number of affected leaves, N – number of assessed leaves.

The disease-affected leaf area was estimated in per cent according to methodology (Šurkus & Gaurilčikienė).

Disease severity (R) was calculated according to the formula, having added the per cent of the affected leaf area of each leaf and having divided the sum by the number of assessed leaves:

$$R = \frac{\sum(n \cdot b)}{N},$$ where $\sum(n \cdot b)$ – sum of product of the number of leaves with the same percent of severity and value of severity, N – number of assessed leaves.

Meteorological conditions

Lithuania's Western regions are strongly affected by the maritime climate (in winter it is warmer, in summer, cooler than in eastern regions). Air temperature and amount of precipitation exert a considerable effect on the spread of diseases. The weather conditions were rather diverse during the experimental period, with the amount of precipitation being especially varied.

In 2005, at the beginning of the spring barley growing season, chilly and dry weather prevailed: in May – June the air temperature was by 0.1–0.3°C lower than the long-term mean, and the amount of rainfall by 1.8 times lower than the long-term mean. However, in the first ten-day period of July the mean daily air temperature exceeded the long-term mean by 1.8°C, and the amount of rainfall totalled 36 mm (mean long-term precipitation rate). Intensive rain started only in the middle of July, i.e. after the 2nd assessment of barley diseases. The weather conditions in 2005 were not conducive to the occurrence of barley diseases.

In 2006 the spring was late and dry. Heavy rainfall (61.9 mm) occurred only in the third ten-day period of May.. The high temperature in the second half of June, shortage of rainfall and high radiation afflux created conditions for the development of drought that lasted until the middle of August. During the summer months the amount of rainfall was 99.9 mm, i.e. only 42% of the mean long-term rate.

In 2007, the spring was early. Warm and moderately wet weather prevailed. The mean air temperature of June was 17.1°C or 2.4°C higher than the long-term mean, and that of July was close to the long-term mean. The amount of rainfall that fell during the mentioned summer months was high, by 1.7 and 3 times higher compared with the long-term mean. As a result, favourable weather conditions occurred for the spreading of barley foliar diseases.

For statistical analysis the program STATISTICA 7.0 was used. Statistical data analysis by regression methods were carried out. The following formula was used: $y = a + bx$. Also, the coefficient of correlations (r) was calculated. To assess the probability of differences between test variants the least significant differences (LSD_{05}) were calculated according to the corresponding methodology (Tarakanovas, 1999). The symbols used in the paper: * and ** are significant at a 95 and 99% probability level.

RESULTS AND DISCUSSION

During the experimental period spring barley was affected in total by 6 species of pathogenic fungi. However, *Drechslera teres* (Sacc.) Shoem. causing net blotch, occurred in the spring barley crop most severely during the growing season. The 1.1–1.3 times higher disease incidence and 1.7–2.1 times higher disease severity were recorded in 2006 compared to the net blotch incidence and severity in 2005 and 2007. Although the weather conditions in 2006 were not favourable for the spread of barley foliar diseases due to the general lack of moisture, a higher incidence of all foliar diseases was noted with higher rainfall at the end of May. The dry weather that set in later did not inhibit the spread of barley foliar diseases. In different years, at spring barley booting stage (BBCH 37-39), net blotch had affected from 70-100% of the barley leaves tested and the disease severity was from 4.45-11.50%. At spring barley milk maturity stage (BBCH 73-75), in many cases we recorded 100% incidence of net blotch and an especially high severity. The spread of net blotch was considerably influenced by the ecological conditions of the habitat of the host plant – spring barley. Pre-crops of barley – winter triticale and winter rye – did not have any marked effect on its phytopathological state. But we established statistically significant differences of net blotch incidence and severity on barley grown after different species of perennial grasses were ploughed in as green manure. In 2005, at spring barley booting stage (BBCH 37-39) 1.1–1.2 times higher severity of net blotch was identified on barley that was grown after legumes (red and white clover), compared with barley grown after timothy (Table 1). A similar trend of net blotch spread persisted also at barley milk maturity stage (BBCH 73-75). It was established that legumes incorporated into the soil do significantly increase its nutrient content. This has a positive effect on the formation of cereal productivity elements (Skuodienė & Daugėlienė, 2008). However, in some cases higher nutrient status in the soil promotes the spread of plant diseases. Experiments done at the Lithuanian Institute of Agriculture's Rumokai Research Station during 1998–2000 suggest that with an increasing amount of nitrogen fertilizer incorporated into the soil the severity of net blotch tended to increase (Brazienė & Dabkevičius, 2002). While assessing the character of disease spread it is important to analyse stand density of the crops tested. It has been reported that more favourable conditions for the spread of diseases occur in the stand with a high population density (Robinson & Jalli, 1999). Our experimental evidence suggests that a slightly higher severity of net blotch was established in a denser crop of spring barley, however, this relationship was weak (r = 0.318*). Consequently, we can maintain that the spread of net blotch during the test period was influenced by the spring barley habitat's conditions formed by incorporating the aftermath and/or residues of different perennial grasses into the soil.

In 2006, at spring barley booting stage (BBCH 37-39) the severity of net blotch was by 1.2 times higher in barley grown after red and white clover in the crop rotation of which the aftermath and residues were ploughed in, compared to barley grown after ploughed-in lucerne and timothy in the crop rotation (Table 1).

At barley milk maturity stage (BBCH 73-75) we recorded the highest incidence of net blotch during the entire experimental period: in many treatments the disease severity was as high as 70%.

Table 1. The effect of preceding crops on the occurence of net blotch in spring barley.

Preceding crops of winter cereals – perennial grasses	Preceding crops of spring barley	Experimental year	Stages of spring barley maturity			
			BBCH 37-39		BBCH 73-75	
			Disease incidence	Disease severity	Disease incidence	Disease severity
Red clover – 1st crop for forage, aftermath ploughed in	Triticale	2005	74.25	5.50	100.00	49.29
		2006	91.00	11.38	100.00	68.00
		2007	85.25	8.02	100.00	66.15
	Rye	2005	72.40	5.00	100.00	48.70
		2006	93.00	11.60	100.00	69.92
		2007	93.00	7.72	100.00	57.50
Red clover – cut twice, residues ploughed in	Triticale	2005	75.35	4.95	98.00	46.25
		2006	90.55	11.50	100.00	70.45
	Rye	2005	70.00	5.22	95.00	45.15
		2006	90.25	12.00	100.00	70.00
White clover – 1st crop for forage, aftermath ploughed in	Triticale	2005	75.25	5.40	100.00	48.95
		2006	95.25	10.85	100.00	67.72
		2007	87.46	6.68	100.00	57.50
	Rye	2005	79.55	5.60	100.00	48.00
		2006	97.72	10.62	100.00	70.00
		2007	92.44	5.90	100.00	66.25
White clover – cut twice, residues ploughed in	Triticale	2005	70.00	5.45	99.00	44.14
		2006	95.00	10.95	100.00	68.45
	Rye	2005	70.00	5.90	95.00	45.55
		2006	100.00	9.75	100.00	69.95
Common lucerne – 1st crop for forage, aftermath ploughed in	Triticale	2006	95.00	9.98	100.00	70.95
		2007	100.00	6.60	100.00	66.65
	Rye	2006	100.00	10.45	100.00	70.25
		2007	85.25	7.42	100.00	57.17
Common lucerne – cut twice, residues ploughed in	Triticale	2006	100.00	10.46	100.00	68.95
		2007	85.27	4.95	100.00	61.67
	Rye	2006	92.00	9.95	100.00	69.59
		2007	100.00	7.62	100.00	58.67
Timothy – cut twice, residues ploughed in	Triticale	2005	76.50	4.45	100.00	45.00
		2006	100.00	9.70	100.00	65.50
		2007	80.75	5.05	100.00	47.50
	Rye	2005	75.50	4.50	95.00	43.75
		2006	100.00	9.90	100.00	66.00
		2007	83.25	5.92	100.00	59.50
		$LSD_{05\ Triticale\ 2005}$	3.50	0.55	0.00	1.05
		$LSD_{05\ Triticale\ 2006}$	2.25	1.38	0.00	2.42
		$LSD_{05\ Triticale\ 2007}$	4.55	0.35	0.00	3.15
		$LSD_{05\ Rye\ 2005}$	3.42	0.65	0.00	1.23
		$LSD_{05\ Rye\ 2006}$	1.80	0.45	0.00	2.85
		$LSD_{05\ Rye\ 2007}$	5.65	1.25	0.00	5.95

Moreover, 1.1 times lower net blotch severity was identified in barley grown after timothy in whose crop rotation we ploughed in residues, compared with the disease severity on barley grown after legumes. No relationship was found between net blotch severity and barley stand density (r = 0.172**). In 2007, at spring barley booting stage (BBCH 37-39) 1.6 times higher net blotch severity occurred on spring barley grown after red clover and lucerne (ploughed-in residues), compared with the disease severity on barley grown after timothy and by 1.2 times higher on barley grown after red clover, compared with barley grown after white clover and lucerne in whose crop rotation we ploughed in both residues and aftermath. At barley milk maturity stage (BBCH 73-75), 1.2–1.4 times higher severity of net blotch was identified on barley grown after legumes, ploughed in as green manure, compared with barley grown after timothy (Table 1). A moderately strong correlation (y = 42.086 + 0.055x, r = 0.460**) was established between net blotch severity and spring barley stand density.

CONCLUSIONS

Different perrenial grasses used as green manure in crop rotation had a significant effect on the occurrence of net blotch in spring barley. The spring barley grown after red and white clover (residues and aftermath ploughed in) was 1.1–1.5 times more affected in 2005 and 2007, compared to the spring barley grown after timothy (residues ploughed in), and about 1.2 times less affected grown after lucerne, compared with spring barley grown after other grasses in 2006. Winter cereals as preceding crops did not have any effect on the occurence of net blotch.

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