

Epidemiological studies into *Phoma lingam* (teleomorph *Leptosphaeria maculans*) infections in winter and spring oilseed rape

I. Brazauskiene and E. Petraitiene

Lithuanian Institute of Agriculture, Department of Plant Pathology and Protection,
Instituto alėja 1, Akademija, Kėdainiai distr. LT 58344, Lithuania;
e-mail: brazausk@lzi.lt; egle@lzi.lt

Abstract. Studies of the concentration of ascospores of *Leptosphaeria maculans* (anamorph *Phoma lingam*) in the air, appearance and variation of visual symptoms of phoma stem canker during the growing season of oilseed rape in relation to the main meteorological indicators were carried out. Spore samples, collected over 200 days in 2004 and 2005 using a Burkard spore trap, were analyzed using the method of microscopy. The first ascospores of *Leptosphaeria maculans* were found in the samples from 1 May 2004 and 9 April 2005. The abundance of ascospores in the air depended on the weather factors, especially the amount and frequency of precipitation. The first symptoms of phoma on the leaves of winter oilseed rape in 2004 were recorded at the end of October, and in 2005, in the spring crop on 3 May, i.e. three weeks later, after the first ascospores had been identified in the air. On 7 June 2005 the first symptoms of phoma stem canker were identified on stems of winter oilseed rape. Spring oilseed rape was more tolerant of phoma stem canker, compared with winter oilseed rape. At the end of maturity stage (BBCH 85), 83.2–81.0% of winter oilseed rape and 35.2–28.6% of spring oilseed rape stems with phoma stem canker symptoms were found in 2004 and 2005, respectively. Diseased stems of winter oilseed rape exhibited mostly double phoma symptoms – on the crown and on the stem 5 cm above the crown (78.4% in 2004 and up to 65% of diseased stems in 2005). Diseased stems of spring oilseed rape mainly displayed phoma symptoms 5 cm above the crown (69.2–98.7%).

Key words: Phoma stem canker, epidemiology, oilseed rape

INTRODUCTION

Phoma stem canker (blackleg), caused by *Phoma lingam* (teleomorph *Leptosphaeria maculans*) is a very common and harmful disease of oilseed rape (*Brassica napus* spp. *oleifera*) in many countries, despite the fact that different types (winter, spring) and varieties of oilseed rape are cultivated in differing climatic conditions and cultivation technologies (West et al., 2001). The pathogen survives on crop debris, releasing ascospores (in the autumn in Europe), which infect leaves of oilseed rape plants to produce leaf lesions. The fungus is able to grow biotrophically from the leaf lesions to the stem (Hammond et al., 1985).

-Phoma stem canker infection passes from the autumn-infected leaves onto petioles and stems, which later develops into the rot of stem base - crown canker. From the spring-infected leaves phoma spots are formed on the stem at various heights (Sun

et al., 2000) later in the growing season, especially at the end of vegetation. These spots appear on the stem at flowering or even post-flowering stage and affect rape seed yield (Zhou et al., 1999). This paper describes the abundance of ascospores of *Leptosphaeria maculans* per season in the air and in relation to the rainfall in 2004 and 2005. Appearance and variation of visual symptoms of phoma were assessed.

MATERIALS AND METHODS

Naturally released ascospores of *Leptosphaeria maculans* were collected using a Burkard 7-day volumetric spore trap (Burkard Manufacturing Company Ltd., Rickmansworth, UK). The spore trap was operated in the oilseed rape field from April–December 2004 and in the centre of the inoculated area in 2005. Spore concentration in the air per day was calculated. An automatic weather station (Metpole) was installed in an oilseed rape field near the Burkard 7-day volumetric spore trap. The weather data were collected every 30 minutes and averaged over each day during the oilseed rape growing season. The field experiments were conducted with the winter oilseed rape cvs. ‘Casino’ and ‘Kasimir’ and the spring oilseed rape cvs. ‘Mascot’ and ‘Landmark’. Winter and spring oilseed rape was grown according to the conventional technology.

Phoma stem canker observations before harvest (BBCH 85) were made on 500 stems of winter and spring oilseed rape (2004 and 2005 harvest). The severity of basal stem canker was assessed using a 1–6 scale provided by H. Brun, INRA, Le Rheu, France. Disease severity index (DSI) was calculated using the following formula: $DSI = (0 \times n_1) + (1 \times n_2) + (3 \times n_3) + (5 \times n_4) + (7 \times n_5) + (9 \times n_6) / \text{total no. of examined plants}$. A coefficient (0 to 9) was attributed to each class; n = no. of plants within each specific score. The mean disease incidence (DI) was calculated according to the formula: $DI = AP \times 100 / T$, where AP = number of affected plants, and T = total no. of examined plants.

RESULTS AND DISCUSSION

The first ascospores of *Leptosphaeria maculans* were found in the samples from 1 May 2004 and 9 April 2005. The abundance of ascospores in the air depended on the weather factors, especially the amount and frequency of rainfall. During the period with no rainfall, ascospores either did not spread at all or were identified only sporadically. In 2004 the peaks of ascospore-spread were recorded after heavier rainfall on 12–16 June (max. 420 ascospores per day), 20–22 June (max. 224 ascospores per day), and 16–20 July (max. 593 ascospores per day) (Fig. 1). In August the release of ascospores by *L. maculans* was very intensive; more than 570 ascospores were found in the sample on the 2nd of August, 390 and 455 ascospores, on the 9th and 15th of August, respectively. Only the ascospores that were released in the air during the May–June period could have had a more marked effect on phoma stem canker infection on winter rape sown in 2003. It is likely that the ascospores released in June–July infected spring rape. The ascospores released in the autumn infected the winter rape sown in August 2005. Similar data were obtained in the second experimental year (2005); the abundance of ascospores in the air was also largely dependent on the amount of rainfall. Foreign researchers have also reported that maturation of pseudothecia, ascospore germination of the fungus *Leptosphaeria*

maculans, as well as plant infection are determined by many factors, rainfall being one of the most decisive (West et al., 1999). In 2004, ascospores of *Leptosphaeria maculans* were found in the air until the middle of December, but in 2005, only until the beginning of November. The first symptoms of phoma on the leaves of winter oilseed rape in 2004 were recorded at the end of October, and in 2005 in the spring crop, on 3 May, i.e. three weeks later after the first ascospores had been identified in the air. In 2005, on 7 June, the first symptoms of phoma stem canker were identified on the stems of winter oilseed rape. In the middle of July, the first spots of phoma on the middle and upper leaves and stems of spring oilseed rape were recorded.

Table 1. Epidemiological studies into *Phoma lingam* (teleomorph *Leptosphaeria maculans*) infections in winter and spring oilseed rape.

	Winter oilseed rape				Spring oilseed rape			
	Casino 2004		Kasimir 2005		Mascot 2004		Landmark 2005	
	units	%	units	%	units	%	units	%
Disease severity index (DSI)		5.33		4.22		0.08		0.03
Stems without phoma symptoms	84	16.8	95	19.0	324	64.8	357	71.4
Diseased stems with phoma symptoms (total)	416	83.2	405	81.0	176	35.2	143	28.6
Including: Stems with double phoma symptoms (on the crown and on the stems 5 cm above the crown)	326	78.4	231	57.0	41	23.3	10	7.0
Stems with phoma symptoms only on the crown	80	19.2	142	35.1	0	0	0	0
Stems with phoma symptoms only 5 cm above the crown	10	2.4	32	7.9	135	76.7	133	93.0

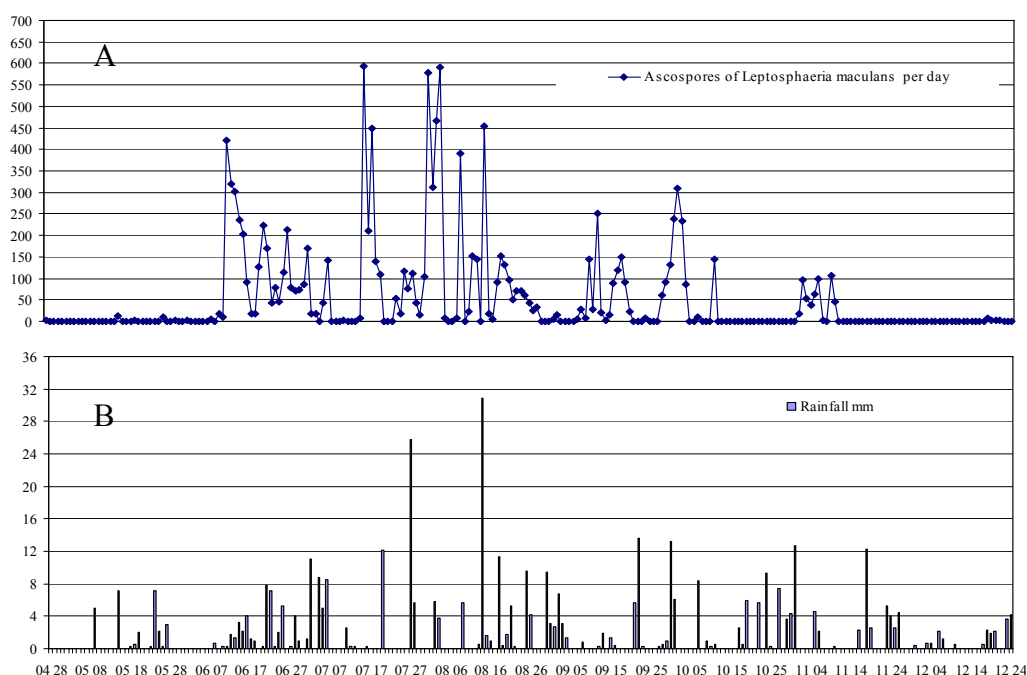


Fig. 1. Seasonal dispersal of A, ascospores by *Leptosphaeria maculans* from a natural field inoculum trapped by a Burkard 7 day spore trap and B, rainfall in 2004.

After the samples of winter and spring oilseed rape stems had been analysed, it was found that phoma stem canker was more common on winter oilseed rape, the disease incidence was over 80 %, and the disease severity index was 5.33 and 4.22 in 2004 and 2005, respectively (Table 1).

Diseased stems of winter oilseed rape more often exhibited double symptoms of phoma stem canker – on the crown and on the stems 5 cm above the crown, 78.4 and 57.0% stems with phoma symptoms only on the crown. This indicates that most of the winter rape plants were already infected with phoma stem canker in the autumn of the sowing year, which agrees with the findings of other authors (Sun et al., 2000; Kuusk et al., 2002). Spring oilseed rape was more tolerant of phoma stem canker, compared with winter oilseed rape. The disease incidence on spring oilseed rape was 35.2–28.6 % with a very low disease severity index. Diseased stems of spring oilseed rape (69.2–98.7%) mainly displayed phoma symptoms 5cm above the crown.

CONCLUSIONS

Our experimental evidence shows a very strong relationship between the abundance of ascospores of phoma stem canker causal agent *Leptosphaeria maculans* fungus in the air and amount and frequency of rainfall. Diseased stems of winter oilseed rape presented with double phoma stem canker symptoms – on the crown and on the stem 5 cm above the crown - and the stems of spring oilseed rape mainly exhibited phoma stem canker symptoms 5cm above the crown. Spring oilseed rape was more tolerant to phoma stem canker, compared with winter oilseed rape.

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