

## **SUSCEPTIBILITY OF DIFFERENT CULTIVARS OF WINTER AND SPRING OILSEED RAPE (*BRASSICA NAPUS* VAR. *OLEIFERA*) TO PHOMA STEM CANKER (*LEPTOSPHAERIA* SPP.) IN LITHUANIA**

Irena BRAZAUSKIENĖ, Eglė PETRAITIENĖ

Lithuanian Institute of Agriculture

Instituto al. 1, Akademija, Kėdainiai distr., Lithuania

E-mail: brazausk@lzi.lt, egle@lzi.lt

### **Abstract**

In Lithuania, spring oilseed rape is more common than winter oilseed rape (winter rape accounts for one fourth of the total area sown with oilseed rape). Until the year 2004, phoma stem canker in Lithuania was not a grave problem either in winter or spring rape crops. However, recently the disease has progressed considerably, especially in winter rape.

Detailed studies revealed differences in blackleg susceptibility in relation to oilseed rape type (winter, spring) and varietal peculiarities. At the end of maturity stage (BBCH 85) on different cultivars of winter oilseed rape there were found 75.5–100% of phoma-affected stems and on different cultivars of spring rape there were found 21.0–76.0% stems with phoma stem canker symptoms. The majority of diseased stems of winter oilseed rape were with double phoma symptoms – on the crown and on the stems 5 cm above the crown. Diseased stems of spring oilseed rape were mainly with phoma symptoms 5cm above the crown. Spring oilseed rape cultivars were more tolerant to phoma stem canker compared with those of winter oilseed rape.

Key words: winter and spring oilseed rape, cultivar, phoma stem canker, disease incidence, disease severity index.

### **Introduction**

Phoma stem canker (complex of *Leptosphaeria maculans* and *Leptosphaeria biglobosa*) is a very common and harmful disease of oilseed rape (*Brassica napus* var. *oleifera*) in many countries. Seed losses caused by this disease most often amount to 10%, although in some cases the losses can be as high as 30–50% /Hall et al., 1993; Zhou et al., 1999/. Different types (winter, spring) and cultivars of oilseed rape are grown and they differ in the susceptibility to this disease. Differences in disease severity occur between sites and seasons, and may be partially attributed to differences in weather conditions favourable for infection of leaves by ascospores of the fungus /Biddulph et al., 1999 a; 1999 b; West et al., 1999; 2001/.

During the recent 5 years, the climate has been warming and the weather in the autumn – winter period has become milder. As a result, the conditions for release of ascospores are conducive until the middle – end of December. The conditions are suitable for the development of phoma lesions on the leaves of WOSR for 90–120 days in the autumn. We think it is one of the reasons, why the disease has progressed in Lithuania after 2004 /Brazauskiene et al., 2007/.

The best way to control various plant diseases is to cultivate resistant varieties, however, the currently Lithuania-grown oilseed rape varieties are not always sufficiently resistant to diseases, especially to phoma stem canker. This paper describes phoma stem canker spread on different cultivars of winter and spring oilseed rape during the seasons of 2004 and 2005 and the susceptibility of different cultivars to this disease.

### **Materials and Methods**

Phoma stem canker observations before harvest (BBCH 85) were made on the stems of winter oilseed rape (WOSR), 50 plants per each cultivar, and spring oilseed rape (SOSR), 50–100 plants per each cultivar in 2004 and 2005, respectively. Susceptibility of different cultivars to phoma stem canker were investigated in field trials and in the plant samples collected from various farmers' fields in different regions.

The severity of basal stem canker was assessed using a 1–6 scale provided by H. Brun, INRA, Le Rheu, France. The disease severity scores were as follows: 1 = no disease, 2 = less than 10% of the cross sectioned stem girdled by lesion; 3 = less than 25% of the cross sectioned stem girdled by lesion; 4 = 25–50% of the cross sectioned stem girdled by lesion; 5 = more than 50% of the cross sectioned stem girdled and weakened by lesion; 6 = dead plant /Kuusk et al., 2002/. The mean disease incidence (% of plants with phoma stem canker) was calculated. Also, the mean disease incidence on the crown (% of plants with phoma symptoms on the crown), on the stems (5 cm above the crown) and % of plants with double disease symptoms (on the crown and on the stems 5 cm above the crown) were calculated. Number of clear phoma spots on the stems above the crown was calculated on each diseased stem of each cultivar of WOSR and SOSR in 2005 and those stems were divided into 6 groups (stems with on average one to six and more phoma spots on the stem). Disease severity index (DSI) for the plants with phoma symptoms on the crown was calculated according to the formula:

$$\text{DSI} = (0 \times n_1) + (1 \times n_2) + (3 \times n_3) + (5 \times n_4) + (7 \times n_5) + (9 \times n_6) / \text{total number of examined plants.}$$

A coefficient (0 to 9) was attributed to each class, and n = number of plants within each specific score. Averaged data were calculated.

### **Results and Discussion**

After the samples of stems had been analysed, phoma stem canker was found to be more common on WOSR compared with SOSR. The incidence of phoma stem canker on the majority of tested cultivars of WOSR amounted to over 90% in 2004. In 2005, in the samples from 6 different cultivars from farmers' fields up to 90% of stems were identified with phoma stem canker symptoms and in the samples from 11 cultivars – over 90% of diseased stems was recorded, and on average amounted to 92.9% (Table 1).

Diseased stems of WOSR were more often with double symptoms of phoma stem canker – on the crown and on the stems 5 cm above the crown, on average 56.9% in 2004 and 68.0% in 2005. Also, in WOSR on average there were identified 36.7% and 25.0% of diseased stems with phoma symptoms only on the crown in 2004 and 2005, respectively. Phoma symptoms on the crown usually develop from the leaves, infected in the autumn. This indicates that over 90% of WOSR plants were infected with phoma

**Table 1.** Phoma stem canker infections on different cultivars of WOSR in 2004 and 2005

Cultivar	Diseased stems %	% of diseased stems		
		A	B	C
2004				
Banjo	90.0 a*	42.0 b	42.0 a	6.0 a
Casino (1)	83.2 a	19.2 a	78.4 cd	2.4 a
Casino (2)	84.0 a	59.5 c	32.1 a	8.4 a
Casino (3)	96.0 a	53.1 c	40.6 a	6.3 a
Celsius	96.0 a	43.8 b	53.1 b	3.1 a
Kasimir F1 (1)	95.0 a	38.9 b	51.6 ab	9.5 b
Kasimir F1 (2)	97.0 a	37.1 b	58.8 b	4.1 a
Kronos F1 (1)	96.0 a	32.3 ab	61.5 bc	6.2 a
Kronos F1 (2)	99.0 a	31.3 ab	61.6 bc	7.1 a
Libea	98.0 a	28.6 ab	62.2 bc	9.2 b
Libomir	99.0 a	31.3 ab	59.6 b	9.1 b
Librett F1	95.0 a	25.3 a	65.3 c	9.4 b
Liclassic	93.0 a	38.7 b	54.8 b	6.5 a
Liprima	94.0 a	46.8 bc	45.7 ab	7.5 a
Lirajet	95.0 a	24.2 a	69.5 c	6.3 a
Lisek	95.0 a	42.1 bc	53.7 b	4.2 a
Silvia	96.5 a	37.6 b	58.4 b	4.0 a
Valesca	98.0 a	24.5 a	72.4 cd	3.1 a
On average	94.4	36.7	56.9	6.4
2005				
Alaska (1)	75.5 a	27.8 ab	61.6 b	10.6 a
Alaska (2)	86.0 ab	23.2 ab	60.5 b	16.3 ab
Alaska (3)	88.5 ab	52.0 c	43.5 a	4.5 a
Alaska (4)	100 b	2.0 a	98.0	0 a
Atila	88.5 ab	22.6 ab	65.0 b	12.4 ab
Celsius	100 b	n. a.	n. a.	n. a.
Courage	98.0 b	24.5 ab	73.5 b	2.0 a
Digger	100 b	32.0 b	64.0 b	4.0 a
Milena	96.0 b	4.2 a	93.7 c	2.1 a
Triangle F1(1)	82.9 ab	37.3 b	44.8 a	17.9 b
Triangle F1(2)	100 b	14.0 ab	86.0 c	0 a
Kasimir F1	81.0 a	35.1 b	57.0 ab	7.9 a
Ibex	92.0 b	n. a.	n. a.	n. a.
Silvia	96.0 b	n. a.	n. a.	n. a.
Kronos F1	100 b	n. a.	n. a.	n. a.
Libea	94.0 b	n. a.	n. a.	n. a.
Sunday	96.0 b	n. a.	n. a.	n. a.
Ryder	98.0 b	n. a.	n. a.	n. a.
On average	92.9	25.0	68.0	7.1

A – stems with phoma symptoms only on the crown; B – stems with double symptoms (on the crown and on the stems 5 cm above the crown); C – stems with phoma symptoms only 5 cm above the crown; n. a. – not assessed; (1) – samples of the same cultivar from different regions  
 \* – values within a column followed by the same letter are not significantly different at  $P = 0.05$

stem canker already in the autumn of the sowing year, which agrees with the findings of other authors /Kuusk et al., 2002/. The level of infection in the same cultivar varied between the fields, probably due to the differences in the weather conditions and in the level of primary infection in the field, and this agrees with other researchers' findings /Sosnowski et al., 2004/.

The disease incidence on different cultivars of SOSR was on average 8.3 and 39.4 % in 2004 and 2005, respectively, with a very low disease severity index (Table 2). Most tolerant to phoma stem canker cvs. – 'Sponsor', 'Liaison', 'Forte', 'Griffin' and 'Ural' were recorded. Diseased stems of different cultivars of SOSR were mainly with phoma stem canker symptoms only 5 cm above the crown (on average 77.5% of diseased stems in 2005). SOSR was more tolerant to phoma stem canker compared with WOSR.

**Table 2.** Phoma stem canker infections on the stems of different cultivars of SOSR in 2004 and 2005

Cultivar	DS %	Cultivar	DS %	% of DS			DSI
				A	B	C	
2004		2005					
Griffin	14.0 b*	Forte	33.0 a	3.0	00	97.0	0.03
Heros	2.0 a	Griffin	48.0 ab	2.1	6.2	91.7	0.04
Landmark	6.0 a	Heros	34.0 a	0	23.5	76.5	0.08
Liason	2.0 a	Landmark (1)	30.1 a	20.6	7.5	71.9	0.12
Mascot (1)	2.0 a	Landmark (2)	34.5 a	14.3	44.7	41.0	0.72
Mascot (2)	35.2 c	Liaison	76.0 c	0	1.3	98.7	0.01
Sponsor	4.0 a	Mascot	41.0 ab	14.3	43.5	42.2	0.62
Star	0 a	Plenty	26.0 a	15.4	19.2	65.4	0.27
Summit	8.0 a	Sponsor	21.0 a	0	4.8	95.2	0.01
SW Partisan	8.0 a	Star	48.0 ab	4.2	12.5	83.3	0.21
Terra F1	8.0 a	SW Partizan	39.0 ab	0	30.8	69.2	0.54
Ural	10.0 a	Terra F1	49.0 ab	4.0	8.2	87.8	0.06
		Ural	32.0 a	0	12.5	87.5	0.04
On average	8.3		39.4	6.0	16.5	77.5	0.21

DS – diseased stems; A – stems with phoma symptoms only on the crown; B – stems with double symptoms (on the crown and on the stems 5 cm above the crown); C – stems with phoma symptoms only 5 cm above the crown; DSI – disease severity index on the crown; (1) – samples of the same cultivar from different regions

\* – values within a column followed by the same letter are not significantly different at  $P = 0.05$

Data from detail assessment of WOSR stems show that 67.5–100% of phoma diseased stems were with phoma on the crown (Table 3). On some cultivars, more than 50% of the stems were rated to the severity score 6 (cvs. 'Alaska', 'Digger' and 'Triangle'). Disease severity index on the crown of different cultivars of WOSR in 2005 was very different – the highest on cvs. 'Triangle' F1 (7.92), 'Digger' (7.72), 'Alaska' (7.60), 'Milena' (7.06), and 'Courage' (6.12). On the stems of 'Alaska', collected from

different farmers' fields, disease severity index was 2.07–5.14. Significant differences between cultivars of WOSR in the incidence and severity of phoma leaf spotting were observed over three seasons in the UK too, and those differences were attributed to the differences in the Rlm genes possessed by the different cultivars /Stonard et al., 2007/. Similarities in the susceptibility of particular cultivars over the seasons suggest that the pathogen population did not change greatly from one season to another.

**Table 3.** The incidence of phoma canker on the crown of different cultivars of WOSR and SOSR in 2005, according to disease severity score

Cultivar	Plants with phoma on the crown %	% of diseased plants according to phoma severity score*					DSI
		2	3	4	5	6	
<b>WOSR</b>							
Field trial							
Alaska	100 a**	4.0 a	6.0 a	6.0 a	24.0 b	60.0 b	7.60 a
Courage	96.0 a	8.3 a	14.6 b	18.8 b	16.7 a	41.7 a	6.12 a
Digger	96.0 a	0 a	2.1 a	6.2 a	29.2 b	62.5 b	7.72 a
Milena	94.0 a	4.2 a	0 a	10.6 b	36.2 b	48.9 ab	7.06 a
Triangle F1	100 a	0 a	8.0 ab	6.0 a	18.0 a	68.0 c	7.92 a
Kasimir F1	74.6 b	18.8 b	15.5 b	13.9 b	12.9 a	37.8 a	4.22 b
Samples from different farmers' fields							
Alaska (1)	84.5	13.6	14.2	15.4	18.3	38.5	5.14
Alaska (2)	72.0	24.3	13.9	13.2	12.5	36.1	3.92
Alaska (3)	77.5	34.2	19.4	14.8	9.0	22.6	3.36
Alaska (4)	67.5	44.4	23.0	12.6	14.8	5.2	2.07
Triangle F1	68.0	39.5	22.7	13.4	2.5	21.9	2.65
<b>SOSR</b>							
Field trial							
Plenty	9.0 b	55.5 b	11.1 a	22.3 b	0 a	11.1 b	0.27 b
Forte	1.0 a	0 a	100 b	0 a	0 a	0 a	0.03 a
Landmark	11.0 b	81.8 c	18.2 a	0 a	0 a	0 a	0.03 a
Mascot	30.0 c	56.6 b	6.7 a	0 a	20.0 b	16.7 b	1.10 c
Samples from different farmers' fields							
Star	8.0	25.0	50.0	25.0	0	0	0.21
Sponsor	1.0	100	0	0	0	0	0.01
Liaison	1.0	100	0	0	0	0	0.01
Mascot	14.0	100	0	0	0	0	0.14
Heros	8.0	100	0	0	0	0	0.08
Ural	4.0	100	0	0	0	0	0.04
Terra F1	6.0	100	0	0	0	0	0.06
Partisan	12.0	75.0	0	0	16.7	8.3	0.54
Griffin	4.0	100	0	0	0	0	0.04
Landmark	11.0	72.7	0	0	9.1	18.2	0.33

DSI – disease severity index on the crown; (1) – samples of the same cultivar from different regions

\* Severity score scale is described in “Material and Methods”

\*\* – values within a column followed by the same letter are not significantly different at  $P = 0.05$

Disease incidence on the crown of SOSR was very low, up to 14%, except cv. 'Mascot', where 30.0% of stems were with phoma on the crown. Diseased plants were mostly with severity score 2 (up to 100% of diseased on the crown plants). DSI on various cultivars of SOSR was very low too, and ranged from 0.01 to 1.10. Most susceptible to phoma stem canker were cvs. 'Mascot' and 'Partisan'.

On different WOSR cultivars 52.6–100 % of stems were identified with phoma spots on the stems 5 cm above the crown in the field trial and 46.5–68.5% of such stems were identified in the samples from different farmers' fields. On the WOSR stems there were identified 1–6 and more phoma spots, on different height of the stems (Table 4). Approximately 90% of the stems were with 1–3 phoma spots, and on 35–55% of the stems only one phoma spot had developed. Only cultivar 'Alaska' showed different results in the field trial, where on 72% of diseased stems 4 to six and more phoma spots were identified, and stems with one phoma spot amounted to 2% . On the stems of different SOSR cultivars, phoma disease incidence was 21.0–77.0% (stems with phoma spots 5 cm above the crown). Cultivars 'Liaison', 'Star', 'Mascot', 'Griffin' and 'Terra F1' were susceptible to phoma. On the stems of different SOSR cultivars, the stems with 1–2 phoma spots prevailed. On 13.0–70.6% of diseased SOSR stems only one phoma spot had developed.

**Table 4.** The spread of phoma spots on the stems of different cultivars of WOSR and SOSR in 2005

Cultivar	*Diseased stems %	% of stems with phoma spots 5 cm above the crown					
		one	two	three	four	five	Six and more
1	2	3	4	5	6	7	8
<b>WOSR</b>							
Field trial							
Alaska	100 a**	2.0	4.0	22.0	20.0	26.0	26.0
Courage	72.0 ab	55.6	22.2	19.4	2.8	0	0
Digger	70.0 ab	51.4	25.7	14.3	8.6	0	0
Milena	92.0 a	28.3	43.5	23.9	4.3	0	0
Triangle F1	84.0 a	35.7	28.6	21.4	7.1	2.4	4.8
Kasimir F1	52.6 b	43.7	31.9	15.6	6.1	2.7	0
Samples from different farmers' fields							
Alaska (1)	46.5	64.5	31.2	3.2	1.1	0	0
Alaska (2)	60.5	41.3	24.8	23.1	6.6	3.4	0.8
Alaska (3)	68.5	40.1	25.5	21.2	10.9	2.3	0
Alaska (4)	54.5	35.8	24.8	14.7	20.2	4.5	0
Triangle F1	51.4	53.3	28.9	16.7	1.1	0	0
<b>SOSR</b>							
Field trial							
Plenty	22.0 a	68.2	13.6	13.6	4.6	0	0
Forte	32.0 b	59.4	34.4	0	6.2	0	0
Landmark	28.6 ab	49.6	37.8	11.2	1.4	0	0
Mascot	25.0 a	56.0	20.0	16.0	8.0	0	0

**Table 4 continued**

	1	2	3	4	5	6	7	8
	Samples from different farmers' fields							
Star		45.0	51.1	22.2	13.3	6.7	6.7	0
Sponsor		21.0	61.9	14.3	9.5	9.5	4.8	0
Liaison		77.0	13.0	26.0	23.4	19.5	11.7	6.4
Mascot		47.0	38.3	42.6	14.9	4.2	0	0
Heros		34.0	70.6	23.5	5.9	0	0	0
Ural		32.0	62.5	31.3	3.1	3.1	0	0
Terra F1		47.0	38.3	27.7	21.3	8.5	4.2	0
Partisan		39.0	48.7	33.3	18.0	0	0	0
Grifin		47.0	51.1	25.5	21.3	2.1	0	0
Landmark		34.0	61.8	20.6	17.6	0	0	0

\* – stems with phoma spots 5 cm above the crown, (1) – samples of the same cultivar from different regions

\*\* – values within a column followed by the same letter are not significantly different at  $P = 0.05$

Phoma stem infection and canker were variable across the cultivars tested and across the different fields with the same cultivar. The progression of this disease was highly influenced by oilseed rape type, cultivar and, undoubtedly, weather conditions.

### Conclusions

1. Differences in blackleg susceptibility in relation to oilseed rape type (winter, spring) and varietal peculiarities were revealed. At the end of maturity stage (BBCH 85), on different cultivars of WOSR there were found 75.5–100% and on different cultivars of SOSR 21.0–76.0% phoma diseased stems.

2. The majority of diseased WOSR stems were with double phoma symptoms – on the crown and on the stems 5 cm above the crown, and diseased SOSR stems were mainly with phoma symptoms 5cm above the crown.

3. SOSR cultivars were more tolerant to phoma stem canker compared with WOSR cultivars.

### Acknowledgements

The present study was supported by the Lithuanian State Science and Studies Foundation, project BOKURAS, agreement No. 20/2008.

Received 2008-08-07

Accepted 2008-08-28

## REFERENCES

1. Biddulph J. E., Fitt B. D. L., Welhalm P. K., Gladders P. Effects of temperature and wetness duration on infection of oilseed rape leaves by ascospores of *Leptosphaeria maculans* (stem canker) // European Journal of Plant Pathology. – 1999 a, vol. 105, p. 769–781
2. Biddulph J. E., Fitt B. D. L., Jedryczka M. et al. Effects of temperature and wetness duration on infection of oilseed rape by ascospores of A-group or B-group *Leptosphaeria maculans* (stem canker) // Proceedings of the 10th International Rapeseed Congress, Camberra, Australia. – 1999 b, p. 129
3. Brazauskienė I., Petraitienė E., Povilionienė E. Fomozės (*Leptosphaeria maculans*) epidemiologijos ir išplitimo indikatorių tyrimai žieminiuose rapsuose // Žemdirbystė / Zemdirbyste-Agriculture. – 2007, t. 94, Nr. 3, p. 176–188
4. Hall R., Peters R. D., Assabqui R. A. Occurrence and impact of blackleg on oilseed rape in Ontario // Canadian Journal of Plant Pathology. – 1993, vol. 15, p. 305–313
5. Kuusk A. K., Happstadius I., Zhou L. et al. Presence of *Leptosphaeria maculans* Group A and Group B Isolates in Sweden // Journal of Phytopathology. – 2002, vol. 150, p. 349–356
6. Sosnowski M. R., Scott E. S., Ramsey M. D. Infection of Australian canola cultivars (*Brassica napus*) by *Leptosphaeria maculans* as influenced by cultivar and environmental conditions. Australasian Plant Pathology. – 2004, vol. 33, p. 401–411
7. Stonard J. F., Downes K., Pirie E. et al. Development of phoma stem canker (*Leptosphaeria maculans*) and light leaf spot (*Pyrenopeziza brassicae*) on current and historical oilseed rape cultivars in 2003/04, 2004/05 and 2005/06 UK growing seasons // Proceedings of the 12th International Rapeseed Congress, Wuhan, China. – 2007, IV, p. 197 – 200
8. West J. S., Biddulph J. E., Fitt B. D. L., Gladders P. Epidemiology of *Leptosphaeria maculans* in relation to forecasting stem canker severity on winter oilseed rape in the UK // The Annals of Applied Biology. – 1999, vol. 135, p. 535–546
9. West J. S., Kharbanda P. D., Barbetti M. J., Fitt B. D. L. Epidemiology and management of *Leptosphaeria maculans* (Phoma stem canker) on oilseed rape in Australia, Canada and Europe // Plant Pathology. – 2001, vol. 50(1), p. 10–27
10. Zhou Y., Fitt B. D. L., Welhalm S. J. et al. Effects of severity and timing of stem canker (*Leptosphaeria maculans*) symptoms on yield of winter oilseed rape (*Brassica napus*) in UK // European Journal of Plant Pathology. – 1999, vol. 105, p. 715–728