# Control of alternaria blight in oilseed rape ((*Brassica napus var. oleifera* DC) and turnip rape (*Brassica rapa var. oleifera* DC)

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**Abstract**

Comparison of the tested Alternaria blight control measures used at different times showed that on average during the four experimental years in rape and turnip rape (in total 36 cases), tebuconazole and azoxistrobine were more effective than prochloraz – both products in 24 cases significantly increased seed yield (prochloraz – in 20 cases), average seed yield increase through azoxistrobine application was 406 kg $ha^{-1}$, through tebuconazole application - 389 kg $ha^{-1}$, and through prochloraz application - 296 kg $ha^{-1}$. Alternaria blight tended to decline protein and fat contents in the seed of rape and turnip rape. The optimal application time of Alternaria blight control measures was determined to be at the end of flowering or later, when the first disease symptoms appear on siliques.

**Key words:** oilseed rape, turnip rape, Alternaria blight, disease severity, seed yield, fungicides

## Introduction

Oilseed rape is a major oil crop whose cultivation area is increasing annually in Lithuania. This increase in the production area is determined by a rapidly growing oil demand for food and industrial needs. The largest oilseed cultivation area and the highest yields are obtained in the regions of Central Lithuania. However, oilseed rape productivity is still insufficiently high and part of rapeseed yield is lost annually through diseases.

Micromycetes of *Alternaria* genus affect oilseed rape seedlings, leaves, stems, siliques, and seed. Alternaria blight (*Alternaria* spp.) occurs annually in many countries of the world in oilseed rape crops, however, the disease incidence is diverse. Meteorological conditions have a great effect on the incidence of the disease in separate years (Hong et al., 1996; Kumar, 1997; Meah et al., 2002).

Researchers provide a lot of evidence on Alternaria blight occurrence in various countries (Brun et al., 1987; Meah et al., 1999; Sadowski et al., 2003). Oilseed rape plants are completely non-resistant to this disease; therefore its control is based on soil and crop management practices and fungicide use (Hong and Fitt 1995; Duczek et al.1999). Alternaria blight is a late oilseed rape disease, which is most harmful when spreads on siliques. Alternaria blight-affected siliques mature earlier, the seeds are small and rugose (Verma and Saharan, 1994; Meah et al., 1999). Numerous studies have been conducted with a view to determining the efficacy of fungicide application against various fungal diseases of rape (Bolton and Adam 1992), however, there is no unanimous opinion concerning fungicide application timing against black spot.

This paper presents the data from the field experiments on the incidence and severity of Alternaria blight in winter, spring oilseed rape and spring turnip rape and on the seed yield in relation to the application timing of different fungicides.

## Materials and methods

Field experiments were conducted during 1999-2003 in winter rape (WOSR) crops (2000–2002 cv. Kasimir, 2003 cv. Casino), spring rape (SOSR) cv. Mascot and spring turnip rape (STR) cv. Mammut. The crops were grown following approved technologies. Plant growth stages were assessed according to BBCH scale (Lancashire et. al., 1991). The seed was harvested by a combine harvester Sampo 500, separately for each plot. Seed moisture content (after thrashing) was measured using gravimetric method while estimating dry matter content. The seed yield was weighed and adjusted to 9% moisture.

Investigations of Alternaria blight incidence, severity, and control measures in WOSR, SOSR and STR were conducted according to the same experimental design (in total 12 field experiments). Three different fungicides were used in the experiment: Sportak (a.i. prochloraz, 675 g $ha^{-1}$), Folicur (a.i. tebuconazole, 250 g $ha^{-1}$) and Amistar (a.i. azoxistrobine, 250 g $ha^{-1}$). Comparison of three application times of fungicides was made: 1 – when the first symptoms of Alternaria blight appeared on middle leaves; 2 – at the end of flowering, BBCH 69 (irrespective of the disease incidence); 3 – when the first disease symptoms appeared on siliques. In all field experiments Alternaria blight incidence and severity on siliques were estimated for all treatments, in all plots on 5 earliest formed (lower) siliques on the main stem of 25 marked plants. In total the disease pressure was estimated on 125 siliques per plot (500 siliques per treatment). The content of seed with visual Alternaria blight symptoms was measured by taking a common sample (125 siliques) per each plot and by analysing the sample of 100 siliques. The Alternaria blight-affected area on siliques was identified in per cent according to the scale of Conn et al., (1990). Prior to statistical analysis the data of disease incidence and severity were arcsine-square root transformed: $Y = \arcsin\sqrt{X\%}$. Fisher's Protected Least Significant Difference method was used to determine significant differences between means. Analysis of variance was performed using the computer programme STATISTICA, 5.5 version.

## Results and discussion

The years of 2000 and 2001 according to meteorological factors were characterized as favourable, the years of 2002 and 2003, due to moisture shortage were adverse for the spread of Alternaria blight.

Experimental data suggest that during 2000-2003 all Alternaria blight control measures used at the end of flowering and later, after the first disease symptoms were observed on siliques, significantly declined the disease incidence on siliques in WOSR, SOSR and STR crops until the end of maturation stage (BBCH 89) (Table1).

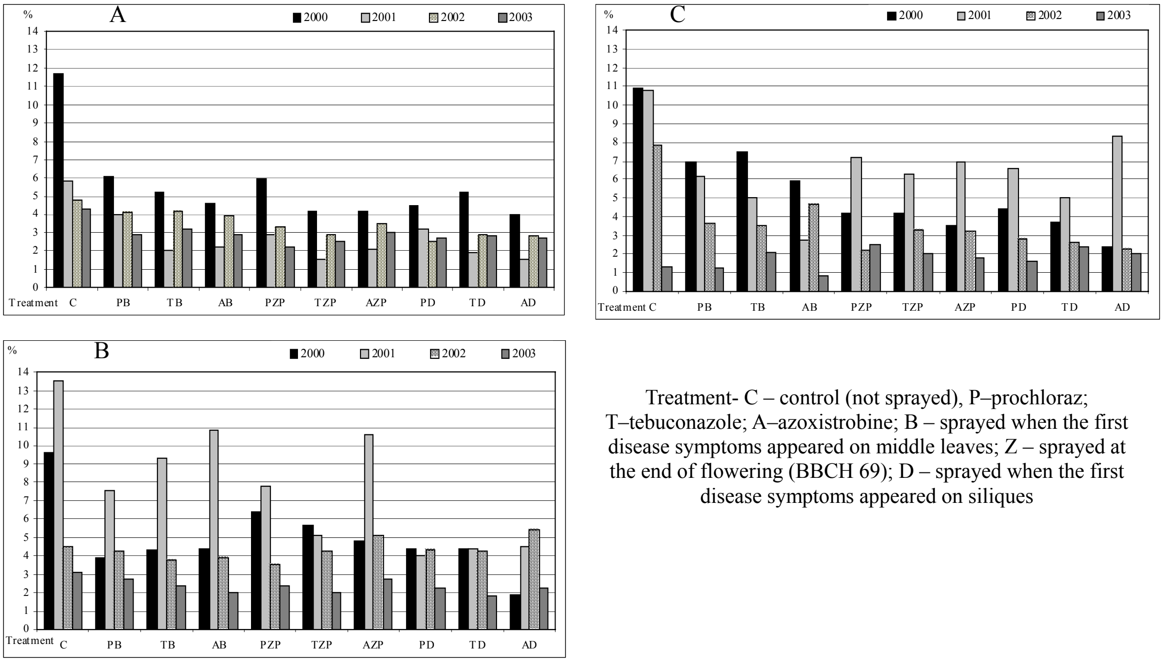
**Table 1. Variation of Alternaria blight incidence % and severity % on WOSR, SOSR and STR siliques (BBCH 87-89) in relation to control measures and their application time in 2000 – 2003**

| Treatment | Alternaria blight | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2000 | | 2001 | | 2002 | | 2003 | |
| | DI % | DS % | DI % | DS % | DI % | DS % | DI % | DS % |
| | | | | WOSR | | | | |
| C | 100 | 6.96 | 100 | 8.25 | 65.8 | 1.66 | 99.2 | 2.12 |
| PB | 98.2 | 4.26** | 100 | 6.56* | 53.0 | 0.86** | 67.4** | 0.90** |
| TB | 98.8 | 4.61** | 100 | 6.46* | 44.0* | 0.74** | 79.6** | 1.15** |
| AB | 99.0 | 4.38** | 100 | 5.26** | 57.4 | 1.05* | 73.8** | 0.98** |
| PZP | 96.2* | 3.04** | 99.8 | 3.42** | 24.0** | 0.24** | 78.0** | 1.03** |
| TZP | 92.6** | 2.88** | 94.4** | 2.16** | 16.8** | 0.14** | 48.8** | 0.53** |
| AZP | 88.0** | 2.46** | 96.0* | 2.02** | 21.4** | 0.22** | 50.2** | 0.52** |
| PD | 87.0** | 2.15** | 89.6** | 1.55** | 26.6** | 0.30** | 38.8** | 0.40** |
| TD | 78.2** | 1.44** | 78.0** | 0.85** | 21.4** | 0.21** | 28.8** | 0.29** |
| AD | 82.4** | 1.60** | 75.2** | 0.88** | 17.6** | 0.18** | 30.2** | 0.31** |
| | | | | SOSR | | | | |
| C | 100 | 13.39 | 100 | 12.05 | 64.2 | 0.77 | 99.8 | 1.83 |
| PB | 100 | 10.19** | 100 | 10.50** | 49.2* | 0.49** | 74.0** | 0.86** |
| TB | 100 | 9.26** | 100 | 9.49** | 50.3 | 0.48** | 68.8** | 0.69** |
| AB | 100 | 7.90** | 100 | 8.93** | 41.6** | 0.48** | 59.6** | 0.60** |
| PZP | 100 | 7.42** | 100 | 3.67** | 37.8** | 0.38** | 51.4** | 0.51** |
| TZP | 100 | 6.03** | 100 | 2.64** | 34.4** | 0.34** | 43.8** | 0.44** |
| AZP | 100 | 5.56** | 100 | 2.18** | 34.0** | 0.34** | 35.6** | 0.36** |
| PD | 96.0** | 2.59** | 100 | 4.76** | 34.0** | 0.34** | 45.4** | 0.45** |
| TD | 73.6** | 1.18** | 90.4** | 1.72** | 27.2** | 0.27** | 37.2** | 0.37** |
| AD | 73.0** | 0.94** | 81.8** | 1.15** | 26.0** | 0.26** | 36.0** | 0.36** |
| | | | | STR | | | | |
| C | 100 | 11.69 | 100 | 4.02 | 66.0 | 0.89 | 77.6 | 1.06 |
| PB | 100 | 8.68** | 100 | 2.62** | 55.4** | 0.62** | 35.2** | 0.35** |
| TB | 100 | 8.24** | 100 | 2.10** | 42.6** | 0.44** | 33.4** | 0.33** |
| AB | 100 | 7.80** | 100 | 1.65** | 44.4** | 0.44** | 25.0** | 0.25** |
| PZP | 97.0** | 3.66** | 95.6** | 1.52** | 29.4** | 0.30** | 26.2** | 0.27** |
| TZP | 100 | 3.44** | 93.2** | 1.50** | 22.8** | 0.23** | 17.6** | 0.18** |
| AZP | 99.6 | 3.01** | 87.4** | 1.03** | 23.0** | 0.23** | 17.2** | 0.18** |
| PD | 100 | 3.94** | 86.0** | 0.98** | 22.2** | 0.22** | 14.4** | 0.27** |
| TD | 94.2** | 2.89** | 77.4** | 0.82** | 14.6** | 0.18** | 12.6** | 0.25** |
| AD | 86.6** | 1.62** | 72.6** | 0.75** | 13.0** | 0.16** | 9.8** | 0.27** |

* and ** significant differences from the control at 95 and 99 % probability level; C – control (not sprayed), P–prochloraz; T–tebuconazole; A–azoxistrobine; B – sprayed when the first disease symptoms appeared on middle leaves; Z – sprayed at the end of flowering (BBCH 69); D – sprayed when the first disease symptoms appeared on siliques.

Alternaria blight control measures had a more significant effect on the disease severity than on incidence. All the tested disease control measures used at all three application times significantly declined the disease severity on siliques. In all cases in sprayed plots a significant reduction in the disease severity on siliques, compared with not sprayed plots, was identified until the end of siliques maturity stage. In most cases significant differences were identified between separate application times of the control measures in WOSR, SOSR and STR crops, however, there were no significant differences between the efficacy of separate disease control measures applied at the same time.

During the experimental years the content of WOSR seed with visual Alternaria blight symptoms per silique in not sprayed plots was up to 11.7 %, of SOSR - up to 13.5 %, and of STR - up to 10.9 % (Fig. 1). In 2000, 2001 and 2003, having used all control measures at all tested times, the content of seed with visual disease symptoms per silique in WOSR significantly declined. In SOSR the efficacy of all disease control measures was significant only in 2000 and in 3 of the 4 experimental years – when the control measures against Alternaria blight were used at the latest date, i.e. after the disease symptoms had appeared on siliques. In STR control measures, compared with not sprayed plots, significantly declined the content of seed with visual Alternaria blight symptoms per silique in 2 of the 4 experimental years (in 2000 and 2002).




Treatment- C – control (not sprayed), P–prochloraz; T–tebuconazole; A–azoxistrobine; B – sprayed when the first disease symptoms appeared on middle leaves; Z – sprayed at the end of flowering (BBCH 69); D – sprayed when the first disease symptoms appeared on siliques

**Fig. 1** Per cent of diseased seed of WOSR (A), SOSR (B) and STR (C) in relation to *Alternaria* blight control measures and their application time in 2000 – 2003

During the period 2000–2003 WOSR seed yield in the control plots was obtained lower by up to 649 kg ha$^{-1}$, of SOSR by up to 735 kg ha$^{-1}$, of STR by up to 1145 kg ha$^{-1}$ lower compared with the plots partly protected against Alternaria blight (Table 2). In terms of seed yield increase, STR responded most sensitively to Alternaria blight damage, SOSR responded slightly less and the least response was identified for WOSR for which the seed yield due to Alternaria blight occurrence declined the least.

**Table 2. Seed yield (9 % moisture content) of WOSR, SOSR and STR in relation to Alternaria blight control measures and their application time (in average for 2000 – 2003)**

| Treatment | WOSR | | SOSR | | STR | |
|---|---|---|---|---|---|---|
| | seed yield kg ha$^{-1}$ | its increase from the control | seed yield kg ha$^{-1}$ | its increase from the control | seed yield kg ha$^{-1}$ | its increase from the control |
| C | 2501 | - | 1518 | - | 1348 | - |
| PB | 2753** | 252 | 1701* | 183 | 1674* | 326 |
| TB | 2899** | 398 | 1741* | 223 | 1872** | 524 |
| AB | 2819** | 318 | 1679 | 161 | 1810** | 462 |
| PZP | 2825** | 324 | 1776** | 258 | 1720** | 372 |
| TZP | 2917** | 416 | 1865** | 347 | 1828** | 480 |
| AZP | 2936** | 435 | 1874** | 356 | 1898** | 550 |
| PD | 2754** | 253 | 1708* | 190 | 1858** | 510 |
| TD | 2801** | 300 | 1883** | 365 | 1801** | 453 |
| AD | 2876** | 375 | 1876** | 358 | 1985** | 637 |

* and ** significant differences from the control at 95 and 99 % probability level; C – control (not sprayed), P–prochloraz; T–tebuconazole; A–azoxistrobine; B – sprayed when the first disease symptoms appeared on middle leaves; Z – sprayed at the end of flowering (BBCH 69); D – sprayed when the first disease symptoms appeared on siliques.

Comparison of the efficacy of three different fungicides and three application dates during the four experimental years in WOSR, SOSR and STR (in total 36 cases) indicates that tebuconazole and azoxistrobine were more effective than prochloraz – both products significantly increased seed yield in 24 cases (prochloraz in 20 cases), average seed yield increase through azoxistrobine was 406 kg ha$^{-1}$, through tebuconazole 389 kg ha$^{-1}$, and through prochloraz 296 kg ha$^{-1}$.

Comparison of all the three application dates of fungicides over the four experimental years in WOSR, SOSR and STR suggests that when the fungicides were applied early (after the first Alternaria blight spots had appeared on middle leaves) WOSR, SOSR and STR seed yield increase made up on average 316.4 kg ha$^{-1}$, when the fungicides were applied at the end of flowering the yield increase amounted to 393 kg ha$^{-1}$, and in the case of the latest application time (after the first Alternaria blight spots had appeared on siliques) the seed yield increase totalled 382.4 kg ha$^{-1}$. When the fungicides were used early, significant seed yield increases were obtained in 19 cases (of the 36), using later, at the end of flowering – in 26 cases, and using at the latest date - in 22 cases. Consequently, we can conclude, that the optimal application time of fungicides for control of Alternaria blight in WOSR, SOSR and STR is at the end of flowering or when the first disease symptoms have appeared on siliques. The findings of previously conducted research also demonstrated that *Alternaria brassicae* in oilseed rape was more effectively controlled by the later fungicide treatments (Evans et al., 1988; Bolton and Adam 1992).

Alternaria blight deteriorated seed quality – protein content in the seed samples of WOSR, SOSR from the plots not protected against Alternaria blight was by up to 0.5 in STR seed samples by up to 0.6 percentage unit lower than in the seed from the plots that were partly protected against disease. Alternaria blight also had a negative effect on seed fat content. Seeds of WOSR and SOSR rape from the control plots during 2001 – 2002 was found to have by up to 0.7, STR seed by up to 0.3 percentage unit lower fat content compared with the seed from plots applied with control measures. This fact has been noticed by other researchers (Klodt–Bussman and Paul, 1995). The effect of Alternaria blight on glucosinolate content was not consistent.

## Acknowledgements

The present study was supported by the Lithuanian State Science and Studies Foundation, project 'Investigation of air-born spore concentration of *Phoma*, *Alternaria* and *Dreschlera* fungi using a Burkard spore suction trap' Registration No. T-05182

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