Cultural control: an alternative method for containing phoma stem canker (*Leptosphaeria maculans*) of oilseed rape

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ABSTRACT

Genetic and chemical controls have not succeeded in completely containing phoma stem canker, a major oilseed rape disease world-wide. Cropping systems certainly greatly influence the epidemic cycle of the fungus and their adaptation may provide a good way of reinforcing these controls. However, little information is available on the effects of cultural practices on phoma stem canker development. A factorial field experiment was conducted in 2000/2001 and 2001/2002 at the Experimental Unit of Grignon (Paris basin, France) to analyse the effects of some cultural practices on phoma stem canker development. The effects of 2 sowing dates (an early sowing date, at the beginning of August, and a typical sowing date, at the beginning of September), combined with 2 levels of nitrogen availability during autumn (0 and 250 kg N ha^{-1} supplied during autumn) were analysed on two cultivars (Bristol, susceptible to phoma stem canker; and Pollen, slightly susceptible). Early sowing dates led to smaller stem cankers, whereas high nitrogen availability during the vegetative stage led to higher stem canker development. The results presented demonstrate that cultural practices greatly influence phoma stem canker development and that the adaptation of cropping systems may be an effective way of controlling the disease. The results presented will contribute towards defining Integrated Pest Management strategies for oilseed rape crops.

Key words: blackleg - cultural control - Integrated Pest Management – nitrogen - sowing date

INTRODUCTION

Phoma stem canker is one of the major diseases of oilseed rape world-wide (West et al., 2001). Epidemics are initiated during autumn by air-borne ascospores released from infected stubbles of previous crops. Once in contact with plants, these ascospores germinate and produce leaf lesions. The fungus then grows systemically from the leaf lesions to the stem where it produces cankers. Chemical and genetic controls cannot completely contain this disease. It is therefore necessary to develop alternative methods to control the pathogen, such as adapting cultural practices. However, little is known about the effects of cultural practices on phoma stem canker development. Brunin and Lacoste (1970) showed that the sooner contamination occurred after emergence, the severer the symptoms observed at harvest were. Furthermore, high nitrogen concentration is known to increase the susceptibility of plants to disease (Snoeijers et al, 2000). A field experiment was conducted to: i) test if early sowing dates limit the consequences of contamination during autumn; ii) test if high levels of nitrogen availability during autumn promote the development of the disease; and iii) test if interactions exist between cultivar susceptibility and sowing date, and between cultivar susceptibility and nitrogen availability.

MATERIALS AND METHODS

A field experiment was carried out in 2000/2001 and 2001/2002 at Grignon (Paris Basin) on an orthic luvisol (0.67 gg^{-1} silt, 0.25 gg^{-1} clay and 0.08 gg^{-1} sand). The plots used had not been cultivated with oilseed rape for 4 years to eliminate local inoculum. Epidemics were naturally initiated by the inoculum present in the region. Experimental treatments resulted from the combination of:

- 2 sowing dates - an early date, at the beginning of August (**D1)**, and a normal date, at the beginning of September (**D2)**

- 2 levels of nitrogen availability during autumn - no nitrogen supplied (**N0)**, and 250 kg/ha sprayed in 3 applications within 2 months after sowing (**N+)**
- 2 cultivars – Bristol, susceptible to phoma stem canker (**S**), and Pollen, slightly susceptible (**SS**).

The experimental design was a split-split plot randomised complete block with 3 replications. The sowing date was the main plot factor, cultivar the sub-plot factor and nitrogen availability the sub-sub plot factor.

Atmospheric *Lesptosphaeria maculans* ascospore concentration was recorded on a daily basis. The percentage of plants with foliar lesions (incidence) was observed from emergence to the beginning of winter. Stem canker severity at crop maturity (GS 5.3-5.5: seeds in lower pods green-brown to brown; Harper and Berkenkamp, 1975) was characterised using 6 severity classes. A disease index ranging from 0 for healthy plants to 9 for plants totally lodged because of the disease was used to summarise the observations. Phenological stages of oilseed rape were recorded throughout the crop cycle.

RESULTS

The first detection of significant *Leptosphaeria maculans* ascopores atmospheric concentration occurred on September 13th 2000 and September 20th 2001 respectively (more than 10 ascospores /m^3). For both years, normal sowing dates had attained the 1 to 2-leaf stage when the first contaminations occurred, whereas early sowing dates were at the 6 to 9-leaf stage.

The maximum incidences observed during the vegetative stage were high for normal sowing dates (**D2**) and early sowing dates with high nitrogen availability (**D1N+**) for both years (79% to 97%, Fig. 1). On the other hand, early sowings with low nitrogen availability (**D1N0**) led to significantly smaller maximum incidences: 37% in 2000 and 7-12% in 2001.

Disease indexes observed in 2002 were high and greater than those observed in 2001 (Fig. 2). For both years, early sowing dates (**D1**) permitted reducing the severity of stem cankers, whereas high nitrogen availability during the vegetative stage (**N+**) promoted stem canker development. Expected cultivar susceptibilities were not observed in 2001 and did not interact with the 2 cultural practices analysed. In 2002, the expected cultivar susceptibilities were observed and statistically significant interactions were revealed: the effects of sowing date and nitrogen availability were greater for cultivar Pollen than for Bristol. Normal sowing dates with high levels of nitrogen availability during autumn (**D2N+**) led to more severe stem canker development for both cultivars and both years.

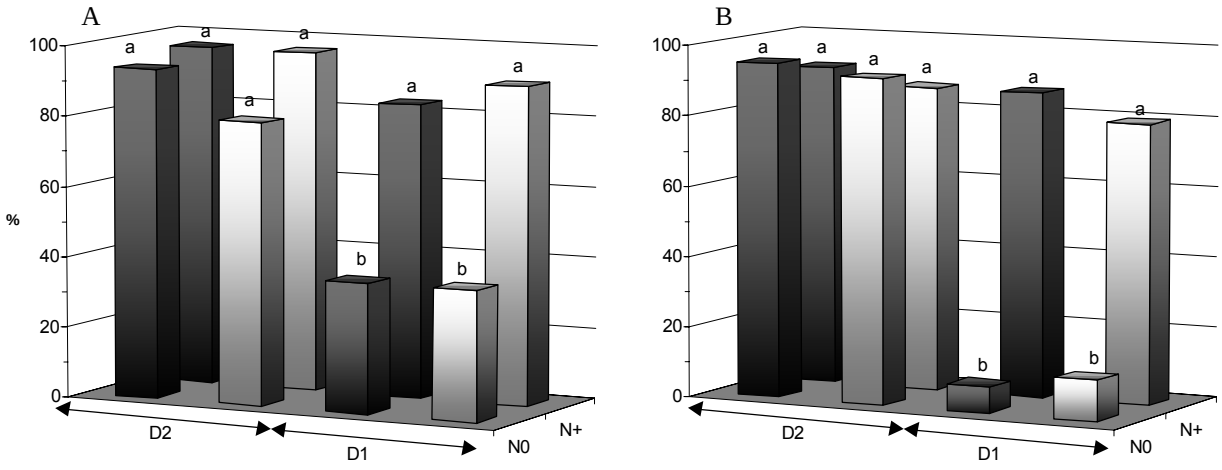

Fig. 1. Maximal incidences observed (percentage of plants with foliar lesions) during the vegetative stage for the first (A) and second (B) year of experiment. Means with the same letter are not significantly different (Student-Newman-Keuls test after angular transformation, $\alpha = 0.05$). ■: Bristol, susceptible to phoma stem canker (**S**); □: Pollen, slightly susceptible (**SS)**; **D1**: early sowing date; **D2**: normal sowing date; **N0**: low nitrogen availability during the vegetative stage; **N+**: high nitrogen availability during the vegetative stage.

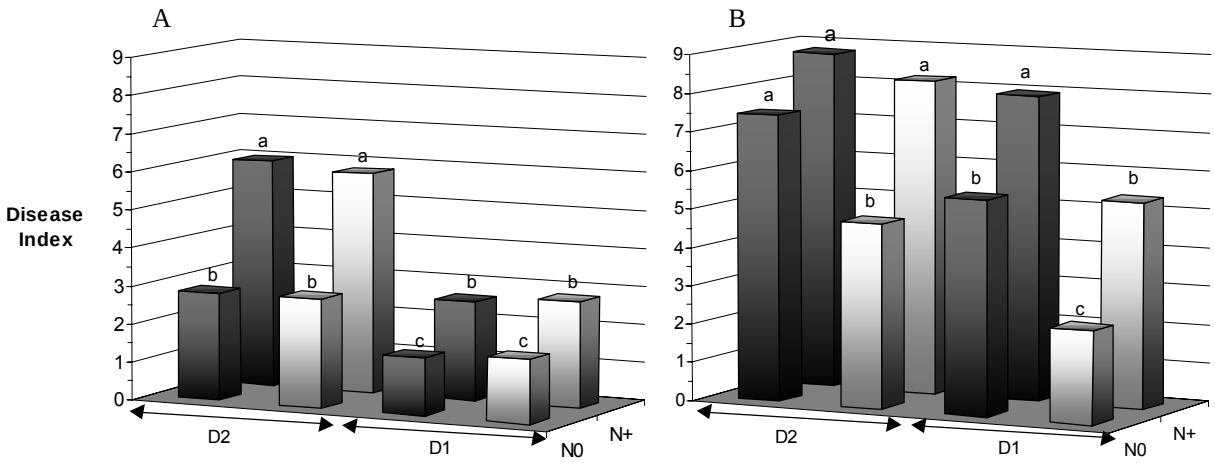

Fig. 3. Disease Indexes at crop maturity for the first (A) and second (B) years of the experiment. Means with the same letter are not significantly different (Student-Newman-Keuls test, n = 3 x 80, α = 0.05). ■: Bristol, susceptible to phoma stem canker (**S**); □: Pollen, slightly susceptible (**SS)**; **D1**: early sowing date; **D2**: normal sowing date; **N0**: low nitrogen availability during the vegetative stage; **N+**: high nitrogen availability during the vegetative stage.

DISCUSSION

For both years, the cultural practices tested led to a wide range of stem canker development at crop maturity (disease indexes from 1.5 to 6 in 2001 and from 2.4 to 8.8 in 2002). This demonstrates that, in addition to climate, certain cultural practices greatly influence phoma stem canker development. The adaptation of cropping systems should therefore be viewed as an effective way of controlling the disease. No simple relationship between observations of leaf lesions during autumn and stem canker at maturity came to light. However, the coincidence between high ascospore atmospheric concentration and early stages of crop development, which are more susceptible to contaminations, appeared to be a key phase of disease development. It therefore appears promising to perform a frequential analysis of the first peaks in ascospore atmospheric concentration over several years for a given region in order to integrate the risk of phoma stem canker development when choosing sowing dates. In addition, the results presented suggest that for situations where soil nitrogen availability is high, particular care should be taken with phoma stem canker management. In such instances, slightly susceptible cultivars should be preferred and fungicide sprays may be considered. In combination with studies on the effects of cultural practices in regard to other pests, these results will contribute toward defining cultural control strategies for oilseed rape crops.

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REFERENCES

Brunin B. and L. Lacoste, 1970: Recherches sur la maladie du colza due à *Leptosphaeria maculans* (DESM.) CES. et DE NOT II. Pouvoir pathogène des ascospores. Ann. Phytopathol., 2 (3), 477-488.

Harper F.R. and B. Berkenkamp, 1975: Revised growth stage key for *Brassica campestris* and *B. napus*. Can. J. Plant Pathol. 55, 657-658.

Snoeijers, S. S., A. Perez-Garcia, M. H. A. J. Joosten, P. J. G. M. de Wit, 2000: The effects of nitrogen on disease development and gene expression in bacterial and fungal plant pathogens. Eur. J. Plant Pathol. 106 (6), 493-506.

West J.S., P.D. Kharbanda, M.J. Barbetti and B.D.L. Fitt, 2001: Epidemiology and management of *Leptosphaeria maculans* (phoma stem canker) on oilseed rape in Australia, Canada and Europe. Plant Pathol. 50, 10-27.