Break Crops Workshop

Processors and Growers Research Organisation

Thornhaugh, Peterborough
24 June 2008

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- Break Crops Workshop -

PGRO, Peterborough
Held in association with PGRO and HGCA
24 June 2008

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PROGRAMME

24 June 2008

10:00	Arrive & coffee
10:30	Introduction from Graham Jellis, BSPP President
10:45	**Keynote Lecture** **Bruce Fitt (Rothamsted Research) Phoma stem canker and light leaf spot in a changing climate**
11:15	Jon West (Rothamsted Research) Forecasting oilseed rape diseases from airborne inoculum
11:35	Peter Gladders (ADAS Boxworth) Challenges from soil-borne oilseed rape diseases, both new and old
11:55	Sally Hilton (Warwick-HRI) The impact of shortened rotations of oilseed rape on the microbial diversity of the rhizosphere
12:15	Lunch and posters
13:15	**Anthony Biddle (PGRO) Pulse diseases - successes and challenges**
13:45	Jane Thomas (NIAB) The downy mildews of peas and field beans
14:05	Natalia Stawniak (NIAB & University of Reading) Race structure of *Ditylenchus dipsaci* and interaction with the faba bean crop
14:25	Anthony Biddle (PGRO) Introduction to field visit
14:30	Tour of field plots
16:00	Tea and depart

Posters

R. Atwood, J. Whipps, P. Mills, G. Bending & D. Chandler

The Role of Pathogens to Yield Decline in Continuous Cropping Oilseed Rape

Warwick HRI

E. F. Boys, K. H. Reilly, J. S. West, C. P. Werner, P. S. Dyer & B. D. L. Fitt

Investigating the phenotype of major gene-mediated resistance to *Pyrenopeziza brassicae* in *Brassica napus*

Rothamsted Research, KWS UK Ltd. & University of Nottingham

Lead Scientist: B.D.L. Fitt

CORDISOR: Components of Resistance to Diseases in Winter Oilseed Rape Cultivars

Rothamsted Research

Lead Scientist: P.Gladders

Disease management in oilseed rape

ADAS

Lead Scientist: P.Gladders

New fungicides for oilseed rape: defining dose-response activity

ADAS

S. L. Rogers, S.D. Atkins & J. S. West,

Development of a quantitative-PCR method to understand the epidemiology of sclerotinia stem rot of oilseed rape

Rothamsted Research

J. S. West, P. Gladders, E. Booth, J. Thomas, R. Jennaway, P. Werner, J Bowman, M. Nightingale, N. Padbury, M. Clarke, S. L. Rogers, D. Kenyon, S.D. Atkins, E.F. Boys, Y.-J. Huang, N. Evans, A.O. Latunde-Dada, Q Li & B. D. L. Fitt

Factors affecting canker and light leaf spot severity in oilseed rape

Rothamsted Research, ADAS, SAC, NIAB, Saaten-Union, KWS-UK, Nickerson, Elsoms Seeds, Syngenta, Monsanto & Anhui Academy of Agricultural Sciences, China.

Phoma stem canker and light leaf spot on oilseed rape in a changing climate

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Phoma stem canker (*Leptosphaeria maculans*) and light leaf spot (*Pyrenopeziza brassicae*) are the two most serious diseases of winter oilseed rape in the UK, accounting for more than £160M of losses (at a price of £300 t^{-1}) despite expenditure of more than £12M on fungicides each growing season (http://www.cropmonitor.co.uk/). The distribution of these two diseases is greatly affected by climate, with phoma stem canker most severe in the warmer, dryer south of England and light leaf spot most severe in the wetter, cooler west and the north of the UK (especially Scotland). Climate change affects plants in natural and agricultural ecosystems throughout the world but little work has been done on the effects of climate change on plant disease epidemics. To illustrate such effects, a weather-based disease forecasting model for phoma stem canker (http://www.rothamsted.bbsrc.ac.uk/ppi/phoma/) was combined with a climate change model predicting UK temperature and rainfall under high and low carbon emissions for the 2020s and 2050s (Evans *et al.*, 2008). Multi-site data collected over a 15-year period were used to develop and validate the weather-based model forecasting severity of epidemics on oilseed rape across the UK. This was combined with climate change scenarios to predict that phoma stem canker epidemics will not only increase in severity but also spread northwards from England to Scotland by the 2020s. By contrast, when similar work was done with a weather-based light leaf spotting forecasting model (Welham *et al.*, 2004; http://www3.res.bbsrc.ac.uk/leafspot/), it predicted that light leaf spot would become a less serious problem throughout the UK, especially in southern England.

Resistance to these two pathogens makes an important contribution to climate change mitigation in the UK, since low-yielding diseased crops require additional nitrogen fertilizer per tonne of yield, and require more land to achieve the same total national production of oilseed rape. There is evidence that the major gene for resistance to *L. maculans Rlm6* is temperature sensitive, since it operated at 15°C but not at 25°C (Huang *et al.*, 2006). Furthermore, worldwide, the most severe epidemics occur in Australia, with its Mediterranean climate. These results provide a stimulus to develop models to predict effects of climate change on other plant diseases, especially in delicately balanced agricultural or natural ecosystems. Such predictions can be used to guide policy and practice in adapting to effects of climate change on food security and wildlife.

Evans N, Baierl A, Semenov MA, Gladders P, Fitt BDL (2008). Range and severity of a plant disease increased by global warming. *Journal of the Royal Society Interface* **5,** 525-531.

Huang YJ, Evans E, Li ZQ, Eckert M, Chevre AM, Renard M, Fitt BDL (2006). Temperature and leaf wetness duration affect phenotypic expression of *Rlm6*-mediated resistance to *Leptosphaeria maculans* in *Brassica napus*. *New Phytologist* **170,** 129-141.

Welham SJ, Turner JA, Gladders P, Fitt BDL, Evans N, Baierl A (2004). Predicting light leaf spot (*Pyrenopeziza brassicae*) risk on winter oilseed rape (*Brassica napus*) in England and Wales, using survey, weather and crop information. *Plant Pathology* **53,** 713-724.

Forecasting oilseed rape diseases from airborne inoculum

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Most fungal diseases of oilseed rape are initiated by airborne spores. The seasonal timing of spore release of each species changes in response to weather with maturation and release of spores typically driven by moisture (rain, dew and relative humidity) and temperature. The dispersal of airborne spores from a source and deposition onto crops at different distances from the source under different atmospheric conditions has been described by numerous mathematical functions. Spore deposition results in individual disease foci when occurrence of viable inoculum and infection conditions are rare; as a gradient in a crop when a large number of spores are produced from a nearby source; or as a uniform infection when there is a large but distant source or multiple local sources of inoculum.

We hypothesize that epidemics of common monocyclic diseases of widespread crops, such as phoma stem canker and sclerotinia stem rot of oilseed rape are primarily started by airborne spores produced by sources either a long distance from the crop or from multiple sites throughout a region; therefore it should be possible to predict such epidemics regionally using suitably located spore samplers.

Appropriate DNA-based diagnostic methods can be integrated with many different types of air samplers and are now providing new information about species that previously could not be identified accurately by visual microscopy methods. For example a new diagnostic for *Sclerotinia sclerotiorum* (Rogers *et al*. 2008) has shown potential for warning of the presence of airborne inoculum. It showed elevated levels of pathogen DNA in air at Rothamsted in April-May 2007 compared to previous years and this coincided subsequently with the highest incidence of sclerotinia stem rot for over ten years (which was unexpected because April 2007 had been unusually dry). However for a reliable warning service to be effective, air samples would need to be analysed and results disseminated within only a few days.

Even where reliable climate-based disease forecasts have been developed (e.g for *Leptosphaeria maculans*), air sampling integrated with DNA-based diagnostics can also provide useful information at the sub-species level, to monitor populations for traits such as the development of fungicide resistance (in a similar way to that found with strobilurin resistance in *Mycosphaerella graminicola*, Fraaije *et al*., 2005) or changes to the pathotype race-structure in response to deployment of resistant cultivars.

Further work is required to investigate the spatial variability in spore numbers in air at different sites and how changes in numbers of airborne spores at particular heights above or distances away from crops are related to subsequent disease severity.

Fraaije BA, Cools HJ, Fountaine J, Lovell DJ, Motteram J, West JS, Lucas JA. 2005 QoI resistant isolates of *Mycosphaerella graminicola* and the role of ascospores in further spread of resistant alleles in field populations. *Phytopathology* **95**: 933-941.

Rogers SL, Atkins SD, West JS 2008 Detection and quantification of airborne inoculum of *Sclerotinia sclerotiorum* using quantitative PCR. *Plant Pathology* (in press).

Challenges from soil-borne oilseed rape diseases, both new and old

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The threat to oilseed rape from soil-borne diseases has increased during the last five years. This has been associated with more widespread adoption of short rotations (1 in 2 or 1 in 3) and favourable weather patterns. Club root (*Plasmodiophora brassicae*) has been more damaging since autumn 2006 in England. Temperature and rainfall factors in August and September are critical as early infection causes plant death by late autumn. With higher temperatures under Climate change scenarios (Evans et al., 2008), oilseed rape could be at risk for a longer period in the autumn and from earlier in the spring. Future management options are likely to include and use of diagnostic tests to guide integrated use of lime and resistant cultivars and extended rotations.

Stem rot (*Sclerotinia sclerotiorum*) was particularly severe in western and southern regions in England in 2007 (Gladders et al., 2008). Few infection events are required during flowering for damaging epidemics to occur (Koch et al., 2006). In future, higher soil temperatures and more variable rainfall are likely to favour earlier disease development. Fungicides can provide very effective control of stem rot, but must be used prophylactically. Early warning systems and use of biological control agents such as *Coniothyrium minitans* are likely to become more important for disease management.

Verticillium wilt (*Verticillium longisporum*) is a new threat to oilseed rape and other brassicas in the UK. It was first confirmed in 2007 at sites in Kent and Herefordshire, but its economic importance is yet to be established. Losses are likely to be greater in warmer and drier summers. Experience in Sweden and Germany where verticillium wilt has been a problem for many years, suggests that longer rotations will be required where it occurs. The development of resistant varieties would also make a valuable contribution to verticillium control.

Evans N, Baierl A, Semenov MA, Gladders P, Fitt BDL (2008). Range and severity of a plant disease increased by global warming. *Journal of the Royal Society Interface* **5,** 525-531.

Gladders P, Oxley SJP, Waterhouse S, 2008. Sclerotinia control in winter oilseed rape: Lessons from 2006 & 2007. Proceedings Crop Protection in Northern Britain 2008, pp. 157-162.

Koch S, Dunker S, Kleinhenz B, Röhrig M, Friesland H, von Tiedemann A, 2006. Development of a new disease and yield loss related forecasting model for sclerotinia stem rot in winter oilseed rape in Germany. IOBC WPRS Bulletin Integrated control in oilseed crops 29 (7), 335-341.

The impact of shortened rotations of oilseed rape on the microbial diversity of the rhizosphere

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Shortened rotations are reported to result in a reduction in yield of many arable and annual horticultural crops including oilseed rape (OSR). These yield declines have been related to a build-up of organisms deleterious to the crop, as well as changes in the microbial population in general. To determine the effects of rotations on the microbial community structure of the soil and rhizosphere, OSR was grown in a range of rotations with wheat including four years of continuous rape and a first year of rape (virgin OSR). DNA was extracted from the rhizosphere and the bulk soil prior to crop harvest and fungal communities profiled using Terminal Restriction Fragment Length Polymorphism (TRFLP) and cloning of rRNA genes. The TRFLP data from the rhizosphere detected six Terminal Restriction Fragments (TRF) that had significantly different abundances between continuous OSR and virgin OSR. Two of these were highly significantly different between treatments and highly abundant in the continuous OSR samples. Cloning revealed that those fungal TRFs which showed greatest increase in abundance in continuous OSR rhizosphere showed 100 % identity to the plant pathogen *Olpidium brassicae* and 95 % identity to the plant pathogen *Pyrenochaeta lycopersici* (tomato corky root).

Pulse diseases – Successes and challenges

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Pulse diseases – Successes and challenges

Peas and beans occupy around 180,000 ha in the UK. The current increase in the planned area for 2009 and beyond is based on the rising cost of nitrogen fertilisers and inputs for other break crops but this will put a strain on the intensity of production and hence pressure on the build up of pulse pests and pathogens.

Pulses are susceptible to several seed borne pathogens including fungi of the *Ascochyta* spp, pea bacterial blight, bean and pea seed borne viruses. Production of healthy seed is important although there are a number of fungi which can be controlled by seed treatments.

Foliar diseases such as chocolate spot in *Vicia* beans, *Peronospora* and *Ascochyta* in peas and beans are routinely protected by fungicide sprays but the reliance on a lessening number of active ingredients will increase the risk of resistant strains developing. The selection of more tolerant varieties will need to be continued although breeding efforts are limited by the relatively low resources available.

Aphid transmitted viruses are becoming more common in pulses and again the limited number of pesticides available will increase the risk of insecticidal resistance developing.

Pressure on rotations also increases the risk of losses caused by root infecting soil borne fungi. In peas, the complex of fungi that is known as foot rot involves at least three distinct fungi. It is exacerbated by frequent cropping and poor soil structure. There are currently no chemical treatments available although long rotations are favoured to slow down the build up of soil borne populations. The complex presents particular difficulties for breeders to produce resistant varieties.

With a projected year on year increase in pulse area the risk of disease will become greater and the challenge is to combine improvements in fungicide availability, a more precise method of application timing and forecasting and improvements in soil management techniques to prevent encouragement of soil borne pathogens while at the same time focusing the breeding efforts to develop resistant or tolerant varieties.

The downy mildews of peas and field beans

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Dry harvested peas, vining peas, broad beans and dry harvested field beans are all at risk of infection by downy mildew (*Peronospora viciae*). Soil-borne oospores give rise to primary, systemic infection, and air-borne conidia generate cycles of secondary infection. As the pea crop increased in area during the 1980s, the availability of "first pea" crop land decreased, and the use of seed treatment became more common. Severe downy mildew on broad beans was reported in 1962, but it was not until the late 1980s that incidence and severity increased markedly on field beans. This appeared to be associated with the use of highly susceptible cultivars, initially cv Troy, and subsequently cv Victor, which was grown on a large area and remained popular for several years because of its human consumption quality and export potential. Though the area of cv Victor has now declined, downy mildew remains common, particularly in the spring sown crop. Seed treatments, though available for beans, are seldom used, and foliar fungicide is needed to prevent significant yield loss in high risk seasons. Control of downy mildew with either seed treatment or foliar sprays is effective, but remains a costly option. Cultivar resistance provides an alternative control measure, and is assessed in national trial series, and there has been significant progress in developing partially or highly resistant field pea cultivars for commercial use, though marrowfat types are still much more susceptible, as are many vining pea cultivars. There is evidence of resistance breakdown, and increased knowledge of pathotype variation is needed. In field beans, a smaller number of cultivars have shown high levels of resistance. There is little, if any, specific resistance breeding or development of screening systems for beans. Currently, field beans are grown on a much larger area than field peas, for a variety of markets and uses, and improved downy mildew resistance in a wider range of backgrounds is needed.

Race structure of *Ditylenchus dipsaci* and interaction with the faba bean crop

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Field beans (*Vicia faba*) are an important crop in the UK with production area estimated at about 180,000 ha. The yield potential and the market value of beans can be reduced due to the presence of the stem nematode *Ditylenchus dipsaci*. Detection of the stem nematode in seed samples of field beans is essential if the spread of the nematode to new areas is to be avoided. The objectives of this study were to establish what races occur in field beans in Great Britain, to help with strategic decisions on cropping plans. Glasshouse experiments were conducted to determine the effect of the widely spread 'giant race' on plant growth of 30 different cultivars of field beans. Damage caused by *D. dipsaci* was marked by severe brown lesion and swelling on the stem. However, the length of the lesion and swollen tissue varied among the cultivars and the tolerant and susceptible types were identified.

The Role of Pathogens to Yield Decline in Continuous Cropping Oilseed Rape

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Supervisors: J. Whipps[1], P. Mills[1], G. Bending[1], D. Chandler[1]

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Oilseed rape (OSR) is an internationally important crop and its cultivation is increasing, driven in part by the demand for biofuels. Previous studies have shown that oilseed rape yields are significantly reduced when grown under a continuous cropping system, however the basis for this decline is unknown. In other crops such as sugarcane, wheat and rice yield decline in continuous cropping systems is generally thought to be caused by build up of pathogens and other deleterious microorganisms in the soil. There are a wide variety of OSR pathogens known, primarily fungi but also some viruses. However, deleterious parasites which colonise roots but which do not cause significant amounts of disease are not known. This research is investigating whether pathogens are a contributory factor to yield decline in OSR when grown continuously.

There are three main research objectives: pathogen identification, development of molecular diagnostics of pathogens and understanding the interactions of pathogens with the soil microbial community. Pathogen identification involves isolating pure cultures from OSR grown in both continuous and alternate cropping systems. The pure cultures are then visually observed under dissecting and compound light microscopes and tentatively identified from the sporulating structures present. Molecular identification using sequencing of the rRNA genes is carried out subsequently to confirm identify of key pathogens. DNA isolated from soil samples from field trials at other OSR sites will also be subjected to molecular analysis to determine whether potential pathogens are present in the soil as well. The interactions with the soil microbial community will be investigated in years two and three. This will involve the study of relative changes in the soil and rhizosphere microbial populations with changes in the pathogen population using culture independent techniques. Specific and general primers based on information generated from the molecular analysis and already available will be used in PCR-Terminal Restriction Fragment Length Polymorphism (TRFLP) to identify overall changes in microbial community structure. PCR-denaturing gradient gel electrophoresis (DGGE) and cloning will be used to identify specific organisms contributing to changes in community structure.

So far, root and leaf samples have been collected from continuous and alternate OSR plots and pure cultures of fungi have been isolated and visually identified. The molecular analysis of the cultures is ongoing. Some potential pathogens have been tentatively identified and once the molecular analysis of the DNA has been completed, Koch's postulates will be carried out to confirm the pathogenicity of the organism.

Investigating the phenotype of major gene-mediated resistance to *Pyrenopeziza brassicae* in *Brassica napus*

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Pyrenopeziza brassicae causes light leaf spot on winter oilseed rape (*Brassica napus*), which is currently controlled through the use of fungicides and cultivars with quantitative resistance. Imola is a new oilseed rape cultivar, thought to contain at least one major resistance gene against *P. brassicae*. Previous work has shown that *P. brassicae* is unable to undergo asexual sporulation on cv. Imola and a "black flecking" phenotype (particularly apparent on leaf vein tissue) is instead observed after inoculation with *P. brassicae* conidia in controlled environment conditions.

An experiment was done in controlled environment conditions in which cv. Imola, a susceptible breeding line and four commercial cultivars (Elan, Winner, Navajo and Hearty) were inoculated with a suspension of *P. brassicae* conidia, and the amount of *P. brassicae* DNA present in the leaf was compared between lines/cultivars using quantitative PCR. This experiment showed that tissue from cv. Imola had significantly less *P. brassicae* DNA than tissue from the other cultivars (including Elan, currently the most resistant commercial cultivar) and that the amount of *P. brassicae* DNA increased with time although cv. Imola remained asymptomatic.

In a separate controlled environment experiment, leaves of cv. Imola and the susceptible cv. Apex were inoculated with a suspension of *P. brassicae* conidia and examined using a Jeol LV 6360 scanning electron microscope. Hyphal growth of *P. brassicae* was observed on leaves of both cultivars, although growth was more extensive on cv. Apex. The "black flecking" on cv. Imola observed with the naked eye was revealed to be associated with the collapse of epidermal cells. Asexual sporulation was observed on cv. Apex using the electron microscope before these symptoms were visible to the naked eye. No asexual sporulation was observed on cv. Imola.

CORDISOR: Components of Resistance to Diseases in Winter Oilseed Rape Cultivars

Lead Scientist: Bruce D.L. Fitt. Rothamsted Research, West Common, Harpenden, Herts AL5 2JQ, UK.

Background

Current resistance ratings based on visual symptoms do not explain resistance operating in all tissues/times. Such information would be valuable for breeding.

Objectives

To test disease progress on 20 oilseed rape cultivars with differing resistance to stem canker and light leaf spot (LLS), in replicated sites throughout the UK.

To compare visible disease symptoms with pathogen DNA levels measured in plant tissue samples by real-time PCR.

To compare yields and disease levels in fungicide-treated and untreated plots to assess disease impact.

Key messages

- Quantitative PCR methods were developed to measure DNA of *L. maculans* (Phoma stem canker) and *P. brassicae* (LLS) in leaf petiole, crown and plant bud tissue samples.
- There was little relationship between LLS severity on leaves in late winter and LLS severity on pods in June.
- There was a reasonable relationship between both LLS pod severity or canker severity and the respective HGCA cultivar resistance scores.

Disease management in oilseed rape

Lead Scientist: Peter Gladders. ADAS Boxworth, Battlegate Road, Boxworth CB23 4NN, UK

Key messages

Sclerotinia

- Higher doses were more effective for sclerotinia control, apply at least 200 litres of water/ha.
- Yield responses were up to 1 t/ha where sclerotinia affecting 25% untreated plants was well controlled.

Light Leaf Spot

- Yield data showed significant differences between products and dose rates. Prothioconazole (as Proline) gave the highest yield, significantly above Prosaro and Punch C, the next best products (Aberdeen site)
- Good control is difficult to achieve if azole resistant strains are present.

Phoma Leaf Spot and Stem Canker

- Half dose applied twice is robust for control of phoma leaf spot and stem canker.
- There were some product differences for efficacy against stem canker, but not for phoma leaf spot control or yield.
- *For oilseed rape disease forecasting and management tools visit: www.hgca.com/tools and www.hgca.com/afd*

Clubroot

- Increasing problem favoured by wet and warm weather in autumns of 2005 and 2006. Obvious root galls are present by the end of September.
- Problems are mainly associated with acid soils, poor drainage or wet patches and short rotations of oilseed rape.
- Control by using lime to raise pH to 7.2-7.5, improve drainage, extend rotations and use Mendel as a resistant variety.

Verticillium Wilt

- First confirmed in the UK in 2007. Use longer rotations where problems occur.

New fungicides for oilseed rape: defining dose-response activity

Lead Scientist: Peter Gladders. ADAS Boxworth, Battlegate Road, Boxworth CB23 4NN, UK

Background

Fungicide expenditure is expected to increase from £12 million/annum to £26 million/annum, but there is little independent data for efficacy and dose to guide decision making. Experiments and targeting phoma leaf spot and stem canker, light leaf spot and sclerotinia stem rot.

Objectives

To determine the dose-response activity of new and standard fungicides against the major diseases of oilseed rape.

Key messages

- Treatments are tested at 0.25, 0.50, 0.75 and 1.00 dose; applied twice for phoma and light leaf spot control and as single sprays for sclerotinia.
- Half dose is robust for phoma leaf spot and stem canker control. Some product and dose differences in efficacy, but yield responses related to disease control and plant growth effects.
- Prothioconazole was the most effective product for light leaf spot (site at Aberdeen).
- Higher does were more effective for sclerotinia control and yield response at high disease sites.

Development of a quantitative-PCR method to understand the epidemiology of sclerotinia stem rot of oilseed rape

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A new specific diagnostic technique was developed that can accurately quantify airborne inoculum of *Sclerotinia sclerotiorum*. DNA was extracted from spores deposited onto wax-coated plastic tapes, such as those used in Burkard (Hirst-type) spore traps and rotating-arm traps. A SYBR-green quantitative PCR (qPCR) method produced a linear relationship between ascospore numbers and *S. sclerotiorum* DNA (mean 0.35 pg DNA per spore) and was able to detect DNA representing as few as 2 ascospores. The technique was insensitive to DNA of the host plant, *Brassica napus*, and other plant pathogens, including *S. minor, S. trifoliorum* and *Botrytis cinerea*, and common airborne fungal genera such as *Cladosporium* and *Penicillium*. Specific quantification of *S. sclerotiorum* was achieved in the qPCR method by including an heating step to 79°C to melt off any exogenous products such as primer dimers that would otherwise falsely contribute to the calculation of target DNA present. This step also eliminated products produced from any DNA of *B. cinerea*, if present in the sample.

The feasibility of using the method in disease forecasting schemes was tested using archived DNA from air samplers that operated at Rothamsted in April-May in three different seasons, which happened to have contrasting sclerotinia stem rot (SSR) epidemics; 2007 had a severe SSR epidemic in England and high numbers of airborne ascospores were trapped at Rothamsted; while both 2003 and 2004 had a very low incidence of SSR in England and low numbers of airborne ascospores trapped at Rothamsted. The severe SSR season of 2007 occurred throughout a large part of northern-Europe and was not predicted in the UK by climate-based disease-forecasts. This study showed that there was no relationship between rainfall and numbers of airborne ascospores of *S. sclerotiorum* present at Rothamsted during the period of infection in the severe SSR season (2007).

In addition to the example application tested in this study, the qPCR method reported here has potential to evaluate the presence and quantity of *S. sclerotiorum* in a wider range of environmental samples such as soil, seed or plant tissues such as petals or stems. In the case of airborne inoculum, further research is required to develop methods to rapidly apply the *S. sclerotiorum*-specific qPCR to air samples and to confirm that airborne inoculum is a reliable indicator of SSR risk by testing over a wider geographical range and number of seasons.

A full report of this study will be published in:

Rogers SL, Atkins SD, West JS (2008) Detection and quantification of airborne inoculum of *Sclerotinia sclerotiorum* using quantitative PCR. *Plant Pathology* (in press).

Factors affecting canker and light leaf spot severity in oilseed rape

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Using the classic 'disease triangle' model (host, pathogen and environment), we can consider factors that affect disease severity. For canker and light leaf spot, the most important host factor is cultivar resistance, which interacts with pathogen virulence and aggressivity, while important environmental factors are climate and fungicide use. It is clear that location, which determines the general climate that a crop experiences, affects both diseases (see Fitt et al; this conference) with light leaf spot favoured by cool, wet conditions (Scotland and northern England) and stem canker severity favoured by warmer conditions (south-east England), which allow greater pathogen growth in the stem. Fungicides can greatly reduce the severity of both diseases compared to untreated crops in some locations or seasons. But they may not be cost-effective everywhere, which is why disease forecasting schemes are important.

The CORDISOR project showed for the first time that *Pyrenopeziza brassicae* infection of the main shoot tip (meristem) of oilseed rape plants in winter was a common occurrence, particularly in Scotland, leading to stunted growth. This is thought to occur when spores, produced on leaves following infection by airborne ascospores, are splashed by rain into the central growing point of the plant. Late-autumn-applied fungicides are therefore important to prevent this. Ascospores of *Leptosphaeria maculans* are produced throughout the autumn and winter, leading to leaf infections from which the fungus is able to grow down the petiole to reach the stem. Continual reapplication of fungicides is not cost-effective, but one or two fungicide applications against *L. maculans* is enough to reduce canker severity substantially. Fungicides are best applied in the autumn to prevent spread from the phoma leaf spot phase of the disease occurring when temperatures and leaf-turnover rates are conducive for the pathogen to reach the stem. Later leaf infections may lead to stem canker but by delaying the fungus reaching the stem, stem canker severity is reduced. Yield loss due to canker occurred in CORDISOR trials only if mean canker severity was >2 (half stem cankered) by mid-June. There were few differences in leaf production and turnover between cvs and little difference between leaf or petiole length between cvs but these factors did vary considerably between different sites, presumably due to soil nutrition and temperature.

Cultivar resistance has a great impact on canker severity. The CORDISOR project tested ways to separate components of 'field' resistance (a product of qualitative and quantitative resistance and disease escape), particularly to measure and quantify quantitative resistance, which is considered to be a more durable trait. General trends in the ranking of cultivars for amount of *L. maculans* DNA in stems in winter showed differences between more susceptible cvs like Bristol and Winner and more resistant cvs like ES Astrid, Hearty, Expert, Canberra and Castille, but pathogen DNA in leaf petiole samples taken earlier in the year was not a good indicator of cultivar resistance. Experiments using ascospore point-inoculations on European and Chinese cultivars grown in very controlled conditions showed large differences in both visible symptoms and amounts of *L. maculans* DNA when particularly susceptible material from China was compared with European cvs which have been bred for resistance to *L. maculans* over the last few decades. This work has identified Chinese lines that have moderate resistance, which could be used in breeding programmes to reduce the impact of canker, should *L. maculans* arise in China.

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