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Research on Pathogens of Oilseed Rape at Rothamsted

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A significant part of the research effort in the Plant Pathology Department at IACR, Rothamsted is devoted to work on the fungal pathogens of oilseed crops, particularly winter oilseed rape *(Brassica napus)*. Nine full time scientists are working on problems as diverse as disease epidemiology and the mechanisms and genetics of resistance to pathogens. Before disease control measures which are both economically and environmentally efficient can be developed, an understanding of the fundamental processes of pathogen/host interactions in crops is needed. This philosophy underlies all the research projects on oilseed rape undertaken in the department. Thus, we are involved in work on mechanims of fungal spore dispersal, the interaction between environmental factors and disease development, biochemical aspects of disease resistance and the genetic basis for disease resistance.

The Plant Pathology Department has a long history, going back to the work of P.H. Gregory, of research on the epidemiology of crop diseases, especially on how disease spreads through the crop. This work is continued in our programme on physical mechanisms of spore transport. Fungal spores can be dispersed by wind or carried in the droplets formed when rain or irrigation drops splash from infected tissue. The department has a unique indoor combined rain tower and wind tunnel with which we can study the effects of wind and rain on spore dispersal under controlled conditions. This facility is being used to study the dispersal of conidia of *Pseudocercosporella capsellae*, the cause of white leaf spot. Field studies show that conidia of this fungus are dispersed only during periods of rain. Rain tower experiments suggest that younger leaves may be a more potent source of conidia than older leaves and that short heavy showers may be most effective in spreading the disease, as most of the available conidia are removed by splash after about 10 minutes of heavy rain.

Field studies of the dispersal of spores from infected crops led to the discovery, for the first time in the UK, of the perfect stage of *Pyrenopeziza brassicae* in an oilseed rape crop. Apothecia develop on infected leaves, especially petioles, after leaf senescence and ascospores are released when the apothecia are turgid, usually after rain. Ascospores can be dispersed by wind for up to three days after rain but few are produced during dry weather. When the weather is favourable there are typically two periods when ascospores are abundant : in the spring around the time of stem extension when rosette leaves infected in the winter begin to die and later in early summer when the leaves infected after stem extension senesce. The disease can spread to volunteer seedlings after harvest and by October apothecia may develop on these plants. These apothecia produce ascospores which can introduce the fungus into autumn sown crops. *P. brassicae* ascospores are small (12 x 3 µm) and dispersal measurements and calculations suggest that they have the potential to travel considerable distances. Therefore infected crops where the perfect stage of the fungus is present may constitute a potential source of infection to other nearby brassica crops. The rapid spread of the disease through some of our experimental plots may been due principally to infection by ascospores. If the perfect stage of the fungus becomes widespread there could be important consequences for agriculture and horticulture in the U.K. Sexual reproduction offers the potential for genetic variability which may affect both pathogenicity and the development of resistance to fungicides.

The dispersal phase of other fungi pathogenic to oilseed rape is also being studied. For example a monitoring programme is identifying the seasonal pattern and environmental conditions needed for the dispersal of *Alternaria brassicae, A. brassicicola* and *Leptosphaeria maculans* in oilseed rape crops. Such information is needed to help identify periods when the crop is most suceptible to infection.

Projects to further our understanding of other phases in disease epidemic development are also being pursued. The biological and environmental constraints controlling the infection, growth and sporulation of *P. brassicae* and *P. capsellae* are being studied. Combining the results of these investigations with information on dispersal processes will lead to more rational control strategies which will reduce the amount of chemical fungicide needed to control disease epidemics.

The effect of disease on the yield and seed quality of crops can be reduced by chemical control or by growing cultivars resistant to pathogen attack. Programmes investigating pathogen host resistance are being pursued on two fronts: through an identification of resistance genes and by studying the biochemical mechanisms of resistance. Work on the genetic basis for resistance to *Peronospora parasitica*, the cause of downy mildew, has identified two new sources of resistance to the fungus. Previously, the only reported major gene for resistance was identified in the spring rape variety Cresor. Material from the UK, France, Germany, Canada and the USA has been screened using a technique developed in the department. Plants in one new group were resistant to *P. parasitica* isolates virulent on Cresor indicating the presence of new major gene(s) for resistance different from that expressed in Cresor. Double-low (low glucosinolate, low erucic acid) winter oilseed rape genotypes are included in the new source material and further work aims towards breeding truly homozygous lines to widen the base of available sources of resistance.

Some double-low varieties of winter oilseed rape are more susceptible to attack by pests and fungal pathogens than varieties with a high glucosinolate content. While field trials have shown greater yield responses to pesticide application for double-low varieties compared with the single-low variety Bienvenu, the increase in yield could not be directly related to observed pest or disease damage, suggesting a physiological (phytolactic) basis for the effect of pesticides. Severe infection by *P. brassicae* tended to increase glucosinolate levels in the seed. Fungicide application tended to decrease the concentration of glucosinolates, but this may have been via an effect on seed mass. The field trials have confirmed that crop protection measures benefit the yield and seed quality of double-low varieties in particular.

Because glucosinolates appear to be implicated in resistance to pests and diseases we have projects to investigate the biochemical basis for resistance. This work forms part of a co-ordinated programme aimed at reducing the need for chemical based crop protection. Glucosinolates are parent compounds of a range of hydrolysis products which are released by enzyme action when tissues are damaged. We have shown that some of these hydrolysis products are toxic to a range of fungal pathogens at concentrations within the limits detected in oilseed rape leaves. We are also studying the relationship between disease severity and the concentration in tissues of particular glucosinolates before and after infection by the common fungal pathogens of oilseed rape. This includes determining if the conditions within the leaf during infection are favourable for the release of glucosinolate hydrolysis products. When we have identified the importance of particular glucosinolates in disease resistance we hope to be able to suggest how they might be manipulated by plant breeders to improve disease resistance while meeting requirements for seed quality. Furthermore, we are conducting field trials to assess the performance of formulations of synthetic coumpounds designed to release specific glucosinolate hydrolysis products to reduce fungal infection.

The research outlined above is not done in isolation. We have close links with entomologists, plant physiologists and chemists within Rothamsted and have developed links with researchers in Europe and India.