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A New Initiative in Crop Protection Research on Rape

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A major multidisciplinary research initiative on the development of novel plant compounds and biological agents against pests and pathogens of oilseed rape has begun at Rothamsted. The impetus for the new approach came from sectors of the UK food industry requesting that crop protection research be directed toward means of achieving "zero" pesticide residues in agricultural products.If this were to be achieved, it would eliminate the enormous task of testing for pesticide residues. Moreover, concerns for more environmentally sensitive use of existing pesticides, and the health-food lobby, add weight to the need for research towards crop protection strategies involving no, or minimal, use of pesticides on food crops. Novel, cheap, alternative approaches to integrated crop protection are also needed to help increase profitability for the farmer; the cost of pesticide use on rape in the UK in 1988 has been estimated at c. £10M. Damage by pests and diseases has increased in importance with the expansion and intensification of the crop. Control by conventional pesticides brings an increased risk of deleterious effects on beneficial organisms; hazards to honey bees already impose restrictions on the use of insecticides. The Ministry of Agriculture, Fisheries and Food has responded to these concerns by funding nine new posts at Rothamsted for long term research on new crop protection systems for rape.

Rape was chosen as the model crop for the new initiative because Rothamsted already has a core of expertise on its pests, diseases and glucosinolates, has experience with the required multidisciplinary approach and has a successful record in semiochemistry and the use of natural products to minimise pesticide usage. Moreover, the Cruciferae are a likely fertile source of natural plant products with effects on insects and fungi.

The objectives of the research are to develop pest and disease management strategies, using insect- and plant-derived natural products and microbial pathogens of insects, to minimise or eliminate the use of toxic chemicals on the crop. With pests, this will involve the use of semiochemicals, e.g. pheromones and anti-feedants, to manipulate behaviour and direct insect populations to specific, discrete, areas within or close to the main crop where they can be destroyed either by environmentally safe insecticides such as insect growth regulators or by pest specific pathogens. Such an approach to control requires investigations on the production and response to semiochemicals used by pest species to locate host plants, aggregate and oviposit. Active components need to be identified then extracted or synthesized and their biological activity confirmed in the laboratory and in field trials.

Practical use of these plant- or insect-derived compounds will require delivery systems and formulations providing longterm fixed release rates which need to be evaluated. Accurate placement of these materials on foliage, without spray drift, will be necessary; electrostatic techniques developed at Rothamsted will be tested for chemicals and for placement of microbial pathogens of insects. The major insect pests of rape in the UK, *Psylliodes chrysocephala, Ceuthorrhynchus assimilis, Dasineura brassicae* and *Meligethes aeneus,* will be studied to determine those stages in the life cycles most susceptible to behaviour manipulation.

The research programme with fungal pathogens will evaluate the effects of glucosinolates and their metabolites, and also slow release derivatives, from rape and other Cruciferae, on spore germination, mycelial growth, sporulation and pathogenicity. After in vitro tests on these materials, slow release formulations of the most biologically active compounds will be developed for use in field trials. Preliminary laboratory tests at Rothamsted and elsewhere have already shown that some metabolites have activity against the major pathogens *Leptosphaeria maculans, Pyre-*

nopeziza brassicae, Alternaria brassicae, Peronospora parasitica and *Botrytis cinerea,* and that some used in the field can increase yield. Some metabolites active against pathogens are also semiochemicals for insect pests, so interrelated pest and pathogen management based on complex mixtures of natural chemicals with optimized release rates is a likely outcome of the research. Thus, the new approach will require a full investigation of interactions within the ecosystem, including pest-host plant (e.g. *C. assimilis* and rape), pest-pest (e.g. *C. assimilis* and *D. brassicae),* pest-pathogen (e.g. *P. chrysocephala* and *L. maculans)* and pest-insect pathogen interactions.

Successful practical application of results from these studies on metabolites, semiochemicals, pests and pathogens requires that research also be done to assess the physical characteristics of sprays produced by novel and conventaional spray equipment. This work will include assessment of spray deposits, principally of semiochemicals but also of other biological agents and the measurement of their distribution and persistence under field conditions.

In parallel with work on these aspects of crop protection, biochemists will study the detailed enzymology and metabolic regulation of glucosinolate biosynthesis. The aim is to devise effective strategies for manipulating the genes responsible for producing semiochemical and fungicidal secondary plant metabolites. To complement the enzymology there will also be a programme of selection for induced mutants with lesions in the pathway of glucosinolate biosynthesis, and an analysis of these at the genetic, physiological and biochemical levels. It is hoped that this contribution to basic research will underpin and advance breeders' efforts to produce better pest and disease resistant "double low" cultivars. The information combined with knowledge of the biological activity of semiochemicals and metabolites, should provide the basis for genetic manipulation leading to new cultivars with an accurately determined spectrum of biologically useful metabolites in green tissue, yet still meeting EEC requirements for low levels of glucosinolates in seed. The aim would be to engineer a crop so that pest and disease pressure could be countered by tactical production of endogenous crop protection agents. A crop protection system which combines exploitation of externally applied and internally manipulated natural products can be expected to have minimal harmful impact on the environment and leave minimal residues in oil and meal.

All the research outlined will require close collaboration between entomologists pathologists, chemists and biochemists. In keeping with the theme of a team- approach, the new work will be co-ordinated by a scientific management committee comprising the authors of this report.