

BIOLOGICAL CONTROL OF INSECT PESTS ON OILSEED RAPE IN EUROPE

1

David V. Alford¹ describes an EC-funded project on the bio-control of oilseed rape insect pests

Introduction

Oilseed rape is a major arable crop in northern Europe, and is attacked by a wide range of insect pests (Alford, 1999), of which the following are of greatest importance:

- *Ceutorhynchus assimilis* (cabbage seed weevil)
- *Ceutorhynchus napi* (rape stem weevil) – not present in the UK
- *Ceutorhynchus pallidactylus* (cabbage stem weevil)
- *Dasineura brassicae* (brassica pod midge)
- *Meligethes* spp., especially *M. aeneus* (pollen beetle)
- *Psylliodes chrysocephala* (cabbage stem flea beetle).

Traditionally, control of insect pests on oilseed rape has involved the use of pesticides but this has always led to potential conflict, owing to the large number of beneficial insects, including bees and various natural enemies of pests, that visit the crop. Many workers (both within the UK and in mainland Europe) have attempted to rationalise the use of pesticides on oilseed rape by developing economic spray thresholds for the various key pests, and in recent years such strategies have also been developed into decision support systems (Johnen & Meier, 2000). Increasingly, such systems are also taking account of naturally occurring enemies (e.g. Lane & Walters, 1995). Pest control on oilseed rape, therefore, is becoming more a question of pest management, with enhancement and exploitation of natural enemies (parasitoids, predators and pathogens) becoming an important part of the overall crop protection strategy.

In a recent 3-year programme of work, researchers from eight European countries (Austria, Denmark, Finland, France, Germany, Sweden, Switzerland and the UK) collated information on the biological control of insect pests of oilseed rape, under the project acronym BORIS. This work (Alford *et al.*, 2000) has demonstrated the considerable potential of natural enemies for limiting insect pest problems on oilseed rape crops in Europe. A database, giving a range of information, has been established and is currently accessible via the BORIS homepage (<http://www.entom.slu.se/boris/>).



Cabbage stem weevil (*Ceutorhynchus pallidactylus*). Photo courtesy of the author

Pesticides and beneficial insects

Current recommendations for the control of pests of oilseed rape in the UK are summarised by Lane & Gladders (2000). Available insecticides include:

- the carbamates carbofuran and pirimicarb
- the organophosphate phosalone
- a range of pyrethroids (e.g. alpha-cypermethrin, cypermethrin, deltamethrin, lambda-cyhalothrin, tau-fluvalinate and zeta-cypermethrin)

Nowadays, pyrethroids form the basis of chemical control strategies, both within the UK and in mainland Europe.

Pesticides can have unwanted side-effects on beneficial insects, including parasitoids and predators, and their use can conflict with the aims of biological control. However, although most insecticides are known to have adverse effects when tested in the laboratory, this is not necessarily the case under field conditions.

If parasitoids are active in a crop at or around the time of spraying, then most could be killed; spray residues on crops



Pollen beetle (*Meligethes* spp.). Photo courtesy of the author

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could also be lethal, although the most frequently used insecticides (*i.e.* the pyrethroids) seem to have a repellent (Umoru *et al.*, 1996). In oilseed rape crops, predators are less vulnerable to pesticides, as they are often protected by the crop canopy or are hiding in the soil during the time of spraying. However, no crop canopy would be available in the autumn when sprays might be aimed at aphids (virus vectors) or cabbage stem flea beetle. In an advisory context, it is usually emphasised that chemical insecticide treatments should be applied to oilseed rape crops only if pest damage thresholds are exceeded, and this has important implications for the survival and possible enhancement of beneficial organisms.

Parasitoids

Most of the important insect pests of oilseed rape in northern Europe are attacked by parasitoids, notably braconid wasps (family Braconidae), ichneumonid wasps (family Ichneumonidae), and chalcid wasps (superfamily Chalcidoidea, *e.g.* family Pteromalidae).

Data accumulated during BORIS include reference to almost 100 species of parasitoids that attack oilseed rape pests. An indication of the potential of parasitoids in oilseed rape is shown the following examples of parasitism:

- brassica pod midge – over 20 known species of parasitoid recorded attacking the egg or larval stages
- cabbage seed weevil – over 20 known species of parasitoid recorded; often in excess of 70% of larvae attacked by *Trichomalus perfectus* (family Pteromalidae) Europe-wide
- cabbage stem flea beetle – up to 61% of larvae attacked by *Tersilochus tripartitus* (family Ichneumonidae) in France and up to 53% in Germany
- cabbage stem weevil – over 50% attacked by *Tersilochus* spp. in France, Germany, Switzerland and up to 30% by *T. exilis* on spring rape in Sweden
- pollen beetle – nine recorded species of parasitoid, with species of *Phradis* (family Ichneumonidae) and *Tersilochus* being most common; parasitism in excess of 80% is reported
- rape stem weevil – up to 95% of larvae attacked by *Tersilochus* spp. (family Ichneumonidae) in France and up to 81% in Austria

Predators

Frequent mention is made in arable cropping systems to a range of predators, notably ground beetles (family Carabidae) (Kromp, 1999). Rove beetles (family Staphylinidae) and various predators of aphids, *e.g.* ladybirds (family Coccinellidae) and syrphid flies (family Syrphidae) are also of importance.

Within European oilseed rape crops, 25 species of ground beetle are common and of regular occurrence. *Pterostichus melanarius* is generally the most abundant species, but in detail the relative abundance of species varies from country to country and from site to site; in Germany, for example, several species (*e.g.* *Calathus cinctus* and *Harpalus tardus*) are most

numerous in oilseed rape growing on more sandy soils.

Predators are likely to have greatest impact on aphids and on those stages of pests that at some stage in the life-cycle occur on or in the soil. The latter include fully grown larvae and pupae of pests such as brassica pod midge, cabbage stem flea beetle, ceutorhynchid weevils and pollen beetles. Further, predation is likely to be greatest on the soil surface (for example, when fully grown larvae have dropped to the ground prior to pupation), although some common predatory ground beetles, *e.g.* *Clivina fossor* and *Trechus quadristriatus*, will often search for prey within the surface layers of the soil.

Other groups of invertebrates that contribute to the overall beneficial effect of natural predation of pests in oilseed rape fields include: soldier beetles (family Cantharidae); dance flies (family Hybotidae); long-legged flies (family Dolichopodidae); money spiders (family Linyphiidae) and wolf spiders (family Lycosidae). Dance flies (at up to 59 individuals m⁻²) and long-legged flies (at up to 17 adults m⁻²) are considered important predators of brassica pod midge in oilseed rape fields in Germany (Prescher & Büchs, 1996, 1999) and, no doubt, are also of significance elsewhere in Europe.

Pathogens

Few studies are available to indicate the true potential of pathogens in arable cropping systems. However, entomopathogenic fungi (EPFs), entomopathogenic nematodes (EPNs), bacteria, viruses and protozoans all occur naturally in the field and some have been tested experimentally against oilseed rape pests as possible biological control agents.

Oil-spray formulations of the EPF *Metarhizium anisopliae* have been used in the UK against adults of cabbage stem flea beetle, cabbage seed weevil and pollen beetle (*e.g.* Butt *et al.*, 1998); the potential impact of the EPF *Beauveria bassiana* on overwintering survival of pollen beetle adults in Finland has also been investigated (Hokkanen, 1993).

Although some species of EPN (including members of the well-known genera *Heterorhabditis* and *Steinernema*) are exploited commercially for control of crop pests (see Copping 1998), and also occur naturally in the field, few details are available of their effect on oilseed rape pests. However, in France, *Steinernema feltiae* is reported to have halved the number of emerging new-generation rape pests (*e.g.* ceutorhynchid weevils and pollen beetles), and weevils in the genus *Baris* are regularly infested by other EPNs; *Dimorphoparasitenchus barisii*, for example, parasitizes *Baris coerulescens*. Elsewhere in Europe, *e.g.* in Sweden, EPNs are reported infesting flea beetles, including cabbage stem flea beetle.

Bacteria and viruses are not considered of potential value within the context of European oilseed rape pest control, as their hosts tend to be Lepidoptera rather than Coleoptera and Diptera.

With regards protozoans, certain microsporidians (*e.g.* *Nosema meligethi*, the main species upon which studies have been done) have the potential to diminish pollen beetle

populations, by increasing winter mortality, decreasing fecundity and reducing adult longevity. *Nosema meligethi*, however, appears to be restricted mainly to Eastern Europe and Finland.

Future pest management strategies on oilseed rape

Recent studies of the parasitoid *Trichomalus perfectus* in England have confirmed that this parasitoid is an important natural enemy of cabbage seed weevil. This parasitoid is also an important bio-control agent in mainland Europe. Indications are that in the 1970s, this species regularly killed large numbers (often in excess of 70%) of larvae on unsprayed UK oilseed rape crops. The increased incidence of spraying throughout the 1980s led to a significant decline in this natural enemy, probably because the post-flowering application of the organophosphate triazophos coincided with the main flight period of the adult parasitoids. Following co-incidental changes in spray recommendations, notably the withdrawal of triazophos, *T. perfectus* appears to have become more numerous on commercial crops, such that it is again an important factor in the regulation of cabbage seed weevil populations. In the presence of this parasitoid, the requirement for using insecticides is greatly diminished, if not almost entirely avoided, as spray thresholds for cabbage seed weevil are likely to be reached on very few commercial crops; this allows farmers to have increased confidence in the viability of adopting a bio-control strategy for this pest (Alford *et al.*, 1996).

Detailed knowledge of other pest/natural enemy interactions on oilseed rape that will allow changes in current pest management practices is limited. However, there is a clear need to advertise as widely as possible that natural enemies can have a significant impact on oilseed rape pests, and that there are important benefits to be gained from their enhancement and exploitation in modern crop protection practices.

Enhancement of natural enemies needs to involve whole-farm strategies, including where appropriate the provision of suitable on-farm landscape elements to ensure the survival of key components of the system. Weed strips, for example, are known to enhance the beneficial effects in agroecosystems of parasitoids and predators (including those attacking oilseed rape pests such as pollen beetle), and 'push-pull' strategies, such as the timely mowing, might usefully be developed to move populations of such antagonists from field margins into crops, where they can then exert an effect on pest populations. In future, it may also be feasible to attract parasitoids and predators into crops by using semiochemicals (*i.e.* chemicals used in interspecific or intraspecific communication). Conversely, semiochemicals (and perhaps anti-feedants) might have a role in diverting pests away from commercial crops.

Certainly, on-farm habitat management has an important role to play in future ICM (integrated crop management) strategies. This will include the creation, improvement and conservation of habitats suitable for parasitoids and predators, all factors that will reduce the need for farmers to resort to the use of chemical pesticides.

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References

- Alford, D. V. (1999). A Textbook of Agricultural Entomology, 1st edition. Blackwell Science Limited, Oxford, 314 pp.
- Alford, D. V.; Ballanger, Y.; Büchi, R.; Büchs, W.; Ekbom, B.; Hansen, L. H.; Hokkanen, H. M. T.; Kromp, B.; Nilsson, Christer; Ulber, B.; Walters, K. F. A.; Williams, I. H.; Young, J. E. B. (2000). *Minimizing pesticide use and environmental impact by the development and promotion of bio-control strategies for oilseed rape pests*. Final Report, Project FAIR CT 96-1314, 119 pp.
- Alford, D. V.; Walters, K. F. A.; Williams, I. H.; Murchie, A. K. (1996). A commercially viable low-cost strategy for the management of seed weevil populations on winter oilseed rape in the UK. *Proceedings of the Brighton Crop Protection Conference – Pests & Diseases* 2, 609–614.
- Butt, T. M.; Carreck, N. L.; Ibrahim, L.; Williams, I. H. (1998). Honey bee mediated infection of pollen beetle (*Meligethes* spp.) by the insect-pathogenic fungus, *Metarhizium anisopliae*. *Biocontrol Science and Technology* 8, 533–538.
- Copping, L. G. (Ed.) (1998). The BioPesticide Manual. The British Crop Protection Council, Farnham, 333 pp.
- Hokkanen, H. M. T. (1993). Overwintering survival and spring emergence in *Meligethes aeneus*: effects of body weight, crowding, and soil treatment with *Beauveria bassiana*. *Entomologia Experimentalis et Applicata* 67, 241–246.
- Johnen, A.; Meier, H. (2000). A weather-based decision support system for managing oilseed rape pests. *Proceedings of the BCPC Conference – Pests & Diseases*, 2, 793–800.
- Kromp, B. (1999). Carabid beetles in sustainable agriculture: a review on pest control efficacy, cultivation impacts and enhancement. *Agriculture, Ecosystems & Environment* 74, 187–228.
- Lane, A.; Gladders, P. (2000). Pests and diseases of oilseeds, brassica seed crops and field beans. In: *Pest and Disease Management Handbook*. D. V. Alford (Ed.), Blackwell Science Limited, Oxford, in press.
- Lane, A.; Walters, K. F. A. (1995). Prospects for a decision support system for pest of oilseed rape in the UK. *Proceedings of the 9th International Rapeseed Congress, Cambridge, UK*, pp. 1019–1021.
- Prescher, S.; Büchs, W. (1998). Der Einfluß abgestufter Extensivierungsmaßnahmen im Raps- und Erbsenanbau auf nützliche Fliegen (Diptera, Brachycera). *Gesunde Pflanzen* 50, 213–218.
- Prescher, S.; Büchs, W. (1999). Fliegenzönosen (Diptera, Brachycera) aus abgestuft extensiv bewirtschafteten Raps- und Erbsenkulturen. *Verhandlungen der Gesellschaft für Ökologie* 29, 265–269.
- Umoru, P. A.; Powell, W.; Clark, S. J. (1996) Effect of pirimicarb on the foraging behaviour of *Diaeretiella rapae* (Hym. Brac) on host-free and infested oilseed rape plants. *Bulletin of Entomological Research* 86, 193–210.

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