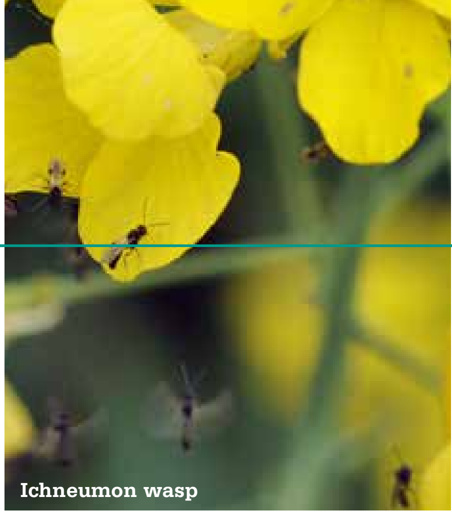
Ladybird



Ichneumon wasp

Extract from the German magazine „Innovation“

Green lacewing

HELP FROM BENEFICIAL INSECTS

Effective pest control in oilseed rape and cereal with the help of beneficial insects

Dr. Meike Brandes und Dr. Udo Heimbach · Braunschweig

Some arable pests have developed resistances to pyrethroid-based insecticides as a result of years of indiscriminate use of such pesticides. The rape pollen beetle is just one oilseed rape pest that has been affected. Not only is this beetle now resistant to pyrethroids, it is also beginning to show resistance to neonicotinoids.

Resistant oilseed rape pests on the rise

As yet, the cabbage seed weevil is still less resistant to pyrethroids than the rape pollen beetle. Resistance occurs mainly in the traditional rape growing regions of northern Germany, although pockets of resistance are also starting to emerge in central and southern Germany.

The flea beetle also shows signs of pyrethroid resistance, though this tends to be concentrated in the northern part of Germany. At present, it is not possible to estimate whether large-scale resistance will also arise in southern Germany since only a small number of samples from the south have been sent to the JKI for resistance monitoring. The first evidence of pyrethroid-resistant populations has come from Bavaria. Following the ban on neonicotinoid seed treatments, spraying with pyrethroids is now the only option for controlling the flea beetle, and this increasing selection for resistance even further.

The rape winter stem weevil which spread to Germany from France and is now causing damage mainly in southern and western Germany also shows signs of pyrethroid resistance. Resistance in France is already widespread and has led to problems associated with controlling the pest in the field. Molecular genetic investigations of only a few populations of this species so far have shown pyrethroid resistance in one population from Rhineland-Palatinate and one from Baden-Württemberg. The peach-potato aphid has shown a high resistance to pyrethroids and other active ingredients. In fact, individual animals have been diagnosed with six different resistance mechanisms.

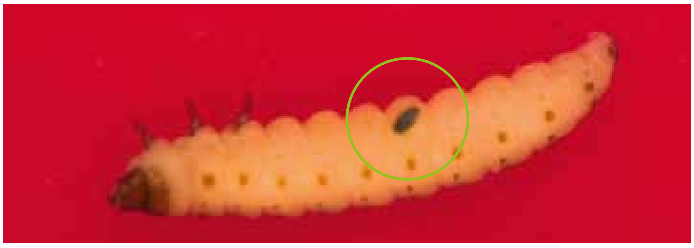
Grain aphids and cereal leaf beetles show resistances

In cereal crops, the English grain aphid and a species of cereal leaf beetle have developed resistance to pyrethroids. Investigations by the JKI have shown that resistant cereal leaf beetles in Germany belong to the species *Oulema duftschmidi.* All Type II pyrethroids (e.g. lambda-Cyhalothrin, Deltamethrin, Cypermethrin, beta-Cyfluthrin) appear to be affected. The first evidence in Germany of knockdown resistance affecting all pyrethroids equally has been found in the English grain aphid. At present little data are available regarding the regional distribution.

Broad spectrum of beneficial insects to combat oilseed rape pests

Chemicals often have little effect as insects become increasingly resistant to insecticides. We often overlook the fact that the crop is also home to countless beneficial insects which can seriously impair the population growth of the harmful pests. Predatory insects such as ground beetles and their larvae (Fig. 1) tend to hunt mainly on the ground and feed on the eggs and larvae of pests. Rove beetles and their larvae hunt for their prey on the ground as

Fig. 1: Ground beetle larva, an active ground predator that feeds on a wide range of prey.



ig. 2: Rape pollen beetle larva parasitised by *Tersilochus heterocerus* (egg of parasitic wasp circled)

well as in the flowers, where they mainly feed on larvae and eggs. Spiders build their webs in the crop to trap brassica pod midges, for example, as well as larvae and beetles. Some spider species catch their prey without webs, preferring to hunt for larvae and beetles that have dropped to the ground. These beneficial insects and spiders are particularly active in May and June as there is plenty of food available at this time. Some 40 different species of ground beetle and up to 20 species of spider have been observed in oilseed rape plots. More than 25 ground beetles and more than 100 rove beetles were recorded per m². There's a lot of activity in cereal crops as well: in wheat more than 100 rove beetles, 20 ground beetles and 100s spiders were often recorded per m².

Furthermore, oilseed rape pests are hosts to a variety of parasitic wasp species in the ichneumonidae family. Some parasitic wasps prefer the eggs and larvae, while others can parasitise and kill adult pests. *Tersilochus heterocerus, Phradis interstitialis* and *P. morionellus* specialise in parasitising rape pollen beetles and are widespread in all rape growing areas. Phradis interstitialis prefers laying its eggs in the eggs of and the first-larval stage rape pollen beetle, whereas T. heterocerus and P. morionellus parasitise the second larval stage. The eggs and larvae of the rape pollen beetle in which parasitic wasps have laid their eggs (Fig. 2) continue to develop normally at first. When the rape pollen beetle larvae have completed their development, they fall to the ground in order to bury into the soil and pupate. This is when the parasitic wasp larvae become active and kill their host. This behaviour can decimate the pest population. In rape pollen beetles, parasitisation rates can rise to over 80%, in other words, this proportion of the population will not develop into new-generation juvenile beetles (Tab. 1). Unfortunately, beneficial parasitic wasps buzzing around the inflorescence during flowering are often mistaken for brassica pod midges and unnecessarily treated with chemicals which in addition may affect the population of parasitic wasps. The major difference between the two species is that the parasitic wasp has a wasp waist which is lacking in the brassica pod midge.

The larvae of the rape stem weevil, the cabbage stem weevil, the cabbage seed weevil and the flea beetle are also favourite hosts of various parasitic wasp species. In the Göttingen area in Lower Saxony, parasitisation rates of up to 52% were recorded for the cabbage stem weevil and up to 21% for the rape stem weevil. Up to 70% of the cabbage seed weevils were parasitised and up to 44% of the flea beetles (data B. Ulber). After killing their host, the parasitic wasp larvae develop into adult insects and remain in their cocoon in the soil on the old oilseed rape field until the following spring. In the case of brassica pod midges too, losses caused by predation, parasitisation, fungal and nematodal attack or other factors such as drought, for example, often amount to over 90%.

Many beneficial insects are hard at work in cereal crops

Many beneficial insects are hard at work in cereal crops too. Ladybirds, hoverflies, green lacewings and parasitic wasps as well as entomopathogenic fungi have a controlling effect on aphids. Aphids are also on the menu for other non-specialised predators such as ground beetles, rove beetles and spiders. During studies conducted at Braunschweig from 1991– 1993, repeated area-based sampling in winter wheat during summer using eclector and suction traps recorded between 70–250 spiders/m² and up to 15

Tab. 1: Migration of rape pollen beetle larvae from winter rape crop to pupate in the Braunschweig area, larval losses and juvenile beetle emergence in untreated control and Biscaya-treated plots

Year	Treatment	Larval migration/m²	Loss by parasitisation	Additional losses e.g. by predators	Juvenile beetles/m² (larval losses)
2014	Control	816	17 %	55 %	230 (72 %)
2014	Biscaya BBCH 62	339	10 %	63 %	93 (73 %)
2015	Control	1716	7 %	43 %	863 (50 %)
2015	Biscaya BBCH 62	728	9 %	24 %	239 (33 %)
2016	Control	1751	56 %	39 %	87 (95 %)
2016	Biscaya BBCH 65	388	57 %	39 %	16 (96 %)
2017	Control	379	71 %	23 %	23 (94 %)
2017	Biscaya BBCH 67	174	58 %	35 %	12 (93 %)
2018	Control	5084	82 %	16 %	114 (98 %)
2018	Biscaya BBCH 65	3499	77 %	22 %	39 (99 %)

ground beetles/m² (more than 200 in the most extreme case) depending on the year, and more than 200 rove beetles/m² each year.

Protecting beneficial insects

The number and diversity of beneficial helpers can be adversely affected by insecticides, which contributes to a steeper rise in pest population. Treatments invariably affect not only the target pests but their natural adversaries as well. Yet some insecticides only repel the beneficial insects for a few days and they return to the crop after a short time. Long-term studies by the JKI in the Braunschweig area have shown that the application of Biscaya during the flowering season significantly reduces the number of rape pollen beetle larvae outwardly migrating to pupate, but has no or only minimal impact on larval losses due to parasitisation or predation by other beneficial organisms (Tab. 1). During the trials it was observed that parasitisation fell slightly in treated plots in the first week following application but after just two weeks the parasitisation rate no longer differed from the control.

However, other insecticides have a broad spectrum of activity yet with unintended side-effects. They also harm beneficial insects. This has been demonstrated by long-term studies at several sites in Germany: after treating oilseed rape with Karate Zeon, in all tests more rape pollen beetle larvae (up to 40%) were found than in the untreated control. This clearly indicates the side-effects of pyrethroid application on predators of the rape pollen beetle. For instance, pyrethroids are known to adversely affect spiders. In the long-term studies, the rape pollen beetles appear to have benefited from the treatment and were free to develop without interference from predators. In general, insecticides should never be used prophylactically but only in a targeted manner when the treatment threshold is exceeded. This protects not only the beneficial insects but also reduces the risk that the pests will continue to develop resistance.

Dr. Meike Brandes
Institute for Plant Protection in Field Crops and Grassland, Julius Kühn-Institut

Dr. Udo Heimbach
Institute for Plant Protection in Field Crops and Grassland, Julius Kühn-Institut