Findings of insecticide monitoring in Nordic and Baltics

Dorte Højland Castberg, Agrolab Consulting ApS (dhc@agrolab.dk)

Key findings

Pollen beetles:

- λ-cyhalothrin resistance is widely spread throughout the region. However, susceptibility is on the rise
- τ-fluvalinate remains effective. However, a drop in susceptibility was observed in 2018
- Acetamiprid remains effective in Scandinavia, but decreased susceptibility was observed in Lithuania

Cabbage seed weevil:

- λ-cyhalothrin remains effective. A few populations have shown decreased susceptibility. Most of the tested samples proved susceptible to λ-cyhalothrin.

Introduction

This report aims to give a short and concise overview of the data obtained by members of the NORBARAG insecticide subgroup from 2016-2024 and described the overall trends observed for resistance monitoring over an eight-year period for pollen beetles and six-year period for cabbage seed weevils.

From the last report, data for τ-fluvalinate susceptibility in 10 Swedish pollen beetle populations have been included.

All members of NORBARAG are encouraged to contribute to the collection of data for future reports by sending an overview of data to the insecticide subgroup chair. A range of actives were tested according to appropriate IRAC methods.

Method

A total of three active substances with two different modes of action were tested using standard IRAC susceptibility test methods. The tested actives were λ-cyhalothrin, τ-fluvalinate (synthetic pyrethroids) and acetamiprid (neonicotinoid).

The standard IRAC susceptibility test is performed as an Adult Vial Test (AVT), where the effect on insects by several dose rates are tested. Glass vials are coated with the relevant active by adding the dissolved active to the vials and letting the solvent evaporate under rotation of vials. Glass vials coated with acetone functions as control treatment.

Figure 1: Example of adult vial test

The target insects (normally 10 adults per vial) are placed in glass vials coated with the relevant insecticide active for 24 hours, after which number of affected and alive beetles are noted and %affected beetles is calculated. In some cases, the insects are moved to control vials for recovery. To ensure movement, beetles should be exposed to light during the experiment.

Active	Mode of action (IRAC)	IRAC Method used	Amount of active tested (ng/cm^2)
λ-cyhalothrin	Pyrethroid (3A)	Method 011	75
		Method 031	15
τ-fluvalinate	Pyrethroid (3A)	Method 011	480
Acetamiprid	Neonicotinoid (4A)	Method 021	400

Methods 011 and Method 021 are developed for testing pollen beetles, while Method 031 is developed for cabbage stem fleas beetle and weevils. For more information on specific IRAC methods, please see https://www.irac-online.org/methods/.

The monitoring results for pollen beetles are divided into three parts, presenting data for each active substance individually. The monitoring results for cabbage seed weevils is presented in a separate section.

Brassicogethes aeneus

Brassicogethes aeneus (also known as *Meligethes aeneus*) is an important pest of oilseed rape particularly in Western Europe. The larvae are up to 3 mm long and white with brown sclerotised plates. Eggs are laid in the flower buds of the host plant. The larvae develop within the flowers. Oviposition damage to the buds of oilseed rape can cause the flowers to drop off. Both adults and larvae feed on the pollen and nectar in the flowers.

Resistance to pyrethroids has been reported in this species since 1999, especially against λ-cyhalothrin being the most monitored pyrethroid. Initial reports suggest that pyrethroid resistance first occurred in North-East France and over the following years has spread to other countries in Europe. Investigations into the mechanism of resistance has primarily identified enhanced metabolism by P450 monooxygenases as the prime mechanism of resistance to pyrethroids. More recently, a target site mutation has been identified in some λ-cyhalothrin resistant populations from Denmark and Sweden[1].

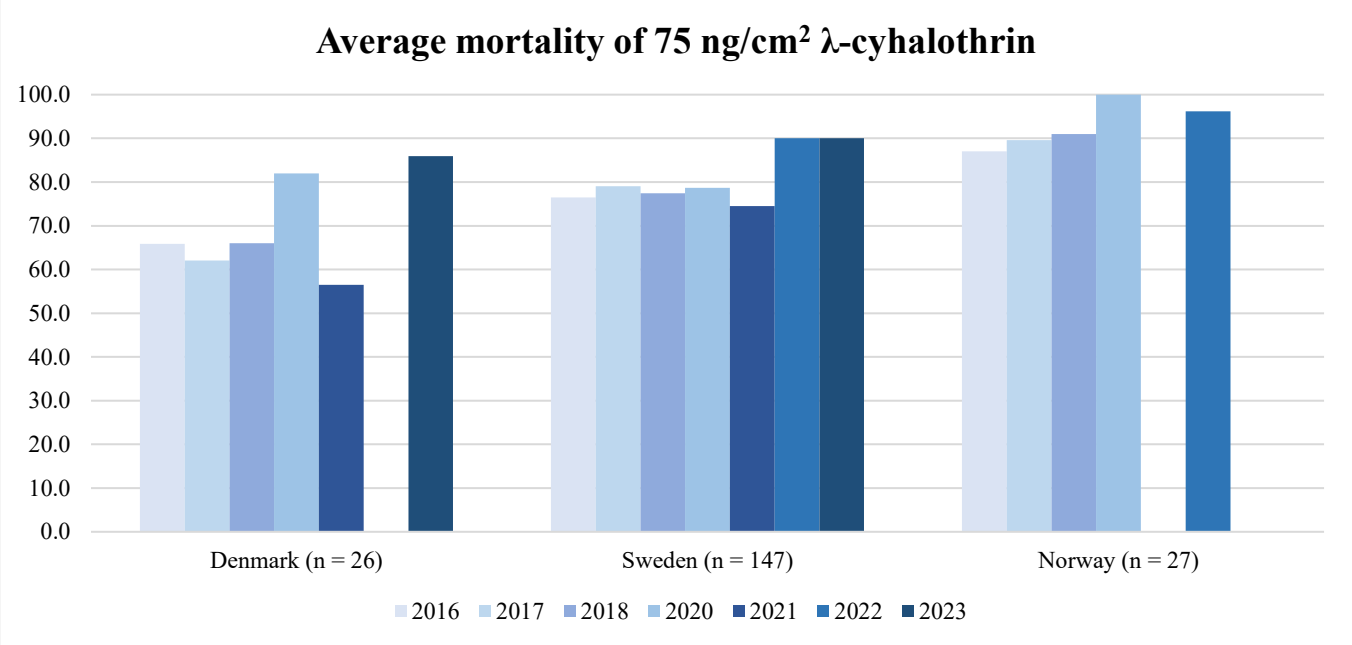
In recent years, monitoring efforts have been decreasing in most of the countries in the Nordic and Baltic region, leading to less data to be included in the following sections.

[1] Kaiser, C., Jensen, KM.V., Nauen, R. et al. J Pest Sci (2018) 91: 447. https://doi.org/10.1007/s10340-017-0856-x

λ-cyhalothrin

IRAC Method 011 tests the effect of synthetic pyrethroids, including λ-cyhalothrin, on pollen beetles in a laboratory setting. It is widely used for monitoring of sensitivity of *B. aeneus* throughout Europe. Beetles are placed in glass vials coated with λ-cyhalothrin for 24 hours, after which number of affected and alive beetles are noted and %affected beetles is calculated. Glass vials coated with acetone functions as control treatment.

The presented data represent the efficacy of 100% field rate (7.5 g/ha λ-cyhalothrin). Data was obtained from Denmark, Norway and Sweden in 2016-2018 and 2020-2023. No data from Finland or the Baltics are included as monitoring has been very limited in recent years. A total of 200 population samples were collected and tested in the lab against λ-cyhalothrin. Samples where the control mortality was above 20% were not included.

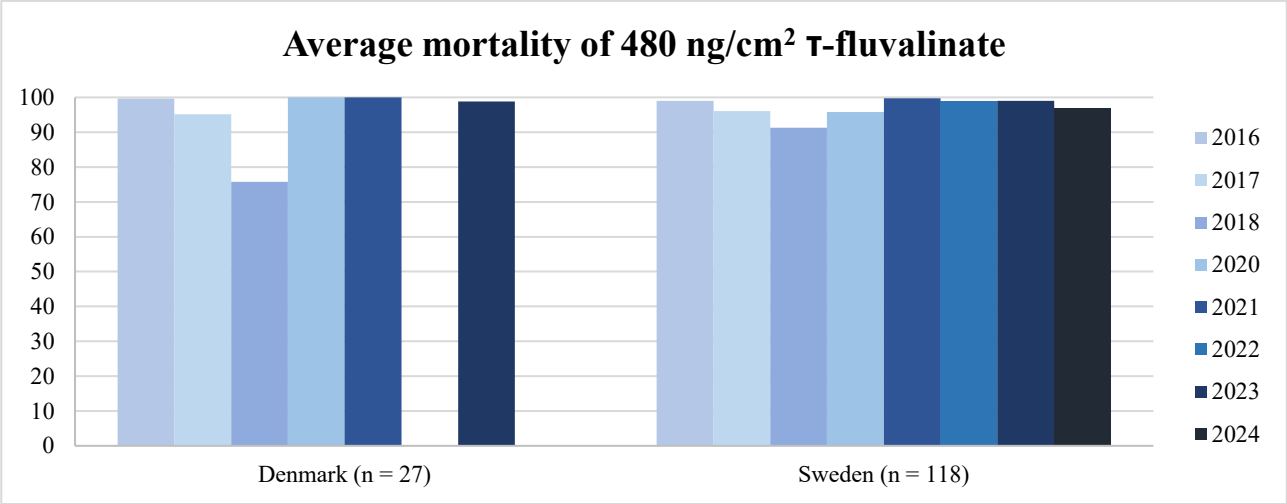


The average mortality of beetles exposed to 75 ng/cm^2 λ-cyhalothrin remained at a similar level in Denmark, Sweden and Norway over a six-year period from 2016-2021. However, in recent years, susceptibility in Denmark and Sweden seem to be on the rise, indicating the possible issue with controlling pollen beetles in the field might be on the reverse.

τ-fluvalinate

IRAC Method 011 tests the effect of synthetic pyrethroids on pollen beetles in a laboratory setting. The standard of Method 011 is λ-cyhalothrin, however, τ-fluvalinate can also be tested with this method as long as differences in inherent potency is considered. Like for λ-cyhalothrin, beetles are placed in glass vials coated with τ-fluvalinate for 24 hours, after which number of affected and alive beetles are noted and %affected beetles is calculated. Glass vials coated with acetone functions as control treatment.

The presented data represent the efficacy of 100% field rate (480 ng/ha τ-fluvalinate). Data was obtained in 2016-2018 and 2020-2024 from Denmark and Sweden. No data from Finland, Norway or the Baltics were included as very little monitoring has been ongoing in recent years. A total of 145 population samples were collected and tested in the lab against τ-fluvalinate. Samples where the control mortality was above 20% were not included.



In general, the average mortality of beetles exposed to 480 ng/cm^2 τ-fluvalinate was above 90% throughout the eight-year period. However, the 2018 data suggests a decrease on susceptibility of pollen beetles against τ-fluvalinate, especially in Denmark. On the other hand, data from 2020 and onwards suggest susceptibility of pollen beetles as mortality of 480 ng/cm^2 τ-fluvalinate was above 95% for the tested populations in Denmark and Sweden.

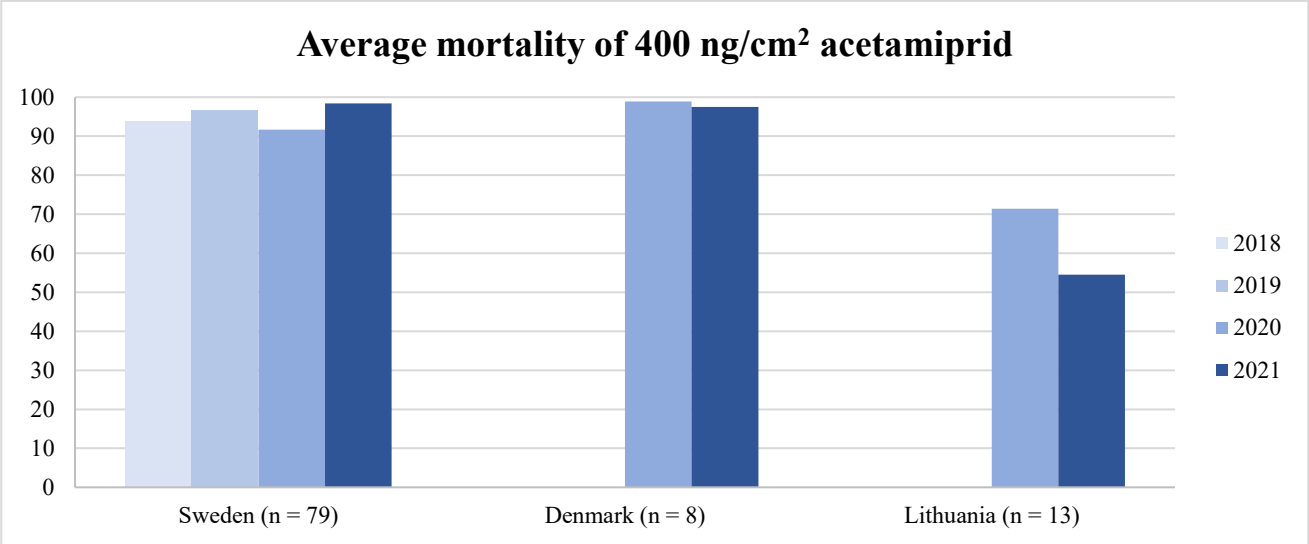
Conclusion on pyrethroids

Both λ-cyhalothrin and τ-fluvalinate function as sodium channel modulators, stimulating repetitive nerve discharges, leading to death through paralysis. Results obtained in the laboratory setting using the adult vial test is not directly referable to field performance of the product but can give indications of possible control issues. Based on 2016-2024 trials, control issues for λ-cyhalothrin might already be present in the field as data show a large proportion of resistant population samples. However, susceptibility is increasing in recent years. The efficacy of 100% field rate of τ-fluvalinate was higher than that of λ-cyhalothrin, but for both actives, susceptibility seems to decrease until 2018, where susceptibility increases.

Acetamiprid

Method 021 tests the effect of neonicotinoids on pollen beetles in a laboratory setting. The standard neonicotinoid used is thiacloprid, however, acetamiprid can also be tested with this method if differences in inherent potency is considered. Both acetamiprid and thiacloprid belong to the group of chloropyridinyl neonicotinoids, so it is sensible to also use Method 021 for the monitoring of acetamiprid. Please note that thiacloprid is no longer approved as the grace period ended in 2021. Therefore, acetamiprid is now used as the representative for neonicotinoids in monitoring efforts. Beetles are placed in glass vials coated with acetamiprid for 24 hours, after which number of affected and alive beetles are noted and %affected beetles is calculated. Glass vials coated with acetone functions as control treatment.

The presented data represent the efficacy of 100% field rate (40 g/ha acetamiprid). Data is presented for Sweden (2018-2021), Denmark and Lithuania (2020 and 2021), where a total of 100 population samples were collected and tested in the lab against acetamiprid. Samples where the control mortality was above 20% were not included. No data have been collected in recent years from the NORBARAG collaborators.



The average mortality of beetles exposed to 400 ng/cm^2 acetamiprid was above 90% in all four years in the Swedish and Danish samples. The data suggest that currently there is no issues in control of pollen beetles, at least in Sweden and Denmark. However, the 13 Lithuanian samples showed a reduced susceptibility of pollen beetles against acetamiprid to a similar degree as observed for thiacloprid before the ban of thiacloprid. More data is required to get the full overview of possible control issues of pollen beetles for the Baltic region.

Conclusion on neonicotinoids

Acetamiprid function as postsynaptic nicotinic acetyl choline receptor modulators, stimulating repetitive nerve discharges, leading to death through paralysis. Results obtained in the laboratory setting using the adult vial test is not directly referable to field performance of the product but can give indications of possible control issues. A total of 100 population samples from Sweden, Denmark and Lithuania were collected and tested against acetamiprid. Based on these data, there is no issues in acetamiprid control of pollen beetles currently in Scandinavia, but issues are already present in the limited number of samples from Lithuania. More data from these and the other countries in the Northern Regulatory Zone is required to give the full overview of the resistance status in the NORBARAG countries.

Ceutorhynchus assimilis

Cabbage seed weevil (*Ceutorhynchus assimilis* (syn. *C. obstrictus*)) is an important pest of oilseed rape, where it affects the pods of rape plants. Infection with *Ceutorhynchus spp.* can significantly reduce the yield - especially if the infestation with weevils is followed by heavy rainfall and frost. The lesions begin to rot and secondary infection with *Phoma lingam*, *Verticillium longisporum* is likely. *Ceutorhynchus spp.* overwinter as adults and migrate into winter rape in early spring.

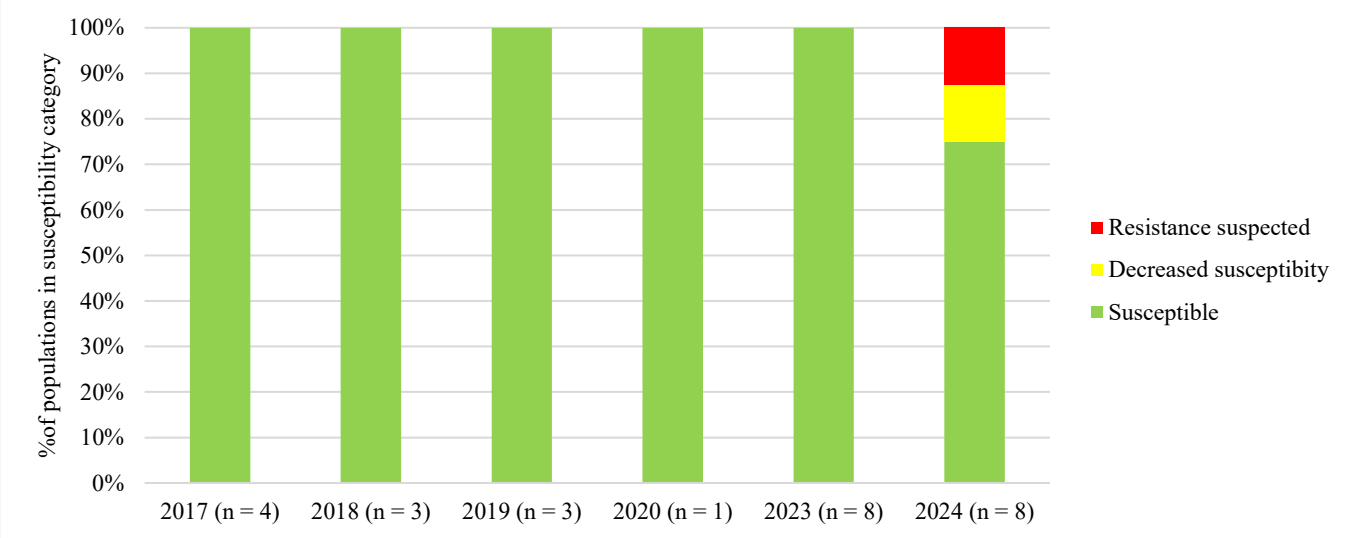
λ-cyhalothrin

IRAC Method 011 is designed for testing λ-cyhalothrin on cabbage seed flea beetle and weevils in a laboratory setting. Weevils are placed in glass vials coated with λ-cyhalothrin for 24 hours, after which number of affected and alive weevils are noted and %affected weevils is calculated. Glass vials coated with acetone functions as control treatment. Sample populations are classified into 3 susceptibility levels; susceptible, decreased

susceptibility and suspected resistance. This classification will be used in this report. Classification of susceptibility levels depends on the effect of 15 ng/cm^3 and 37.5 ng/cm^3 (20% and 50% field rate) on weevil samples.

Dose rate (ng/cm^3)	Affected	Classification
15	100%	Susceptible
15	90-100%	Decreased susceptibility
15	<90%	Suspected resistance
37.5	<100%	

Data was obtained from Sweden in 2017-2020 and from Denmark in 2023 and 2024. A total of 27 weevil population samples were collected and tested in the lab against λ-cyhalothrin.



Of the 27 weevil population samples tested in 2017-2024, a single population had decreased susceptibility to λ-cyhalothrin, while another was classified as “resistance suspected”. Most of the population samples were susceptible to λ-cyhalothrin, indicating no or limited issues with cabbage seed weevils in the field. However, a close eye must be kept on possible shift seen in Denmark in the coming years of monitoring.

Overall conclusion

The susceptibility of pollen beetles over an eight-year period against a range of insecticides was assessed. A total of three active substances with two different modes of action were tested using standard IRAC susceptibility test methods developed for pollen beetles.

More than 200 population samples of pollen beetles were tested in 2016-2023 at 100% field rate. Results show that resistance against λ-cyhalothrin is widely spread throughout the region, but susceptibility is on the rise. For τ-fluvalinate, acceptable efficacy is maintained. From April 2020, the neonicotinoid thiacloprid is no longer approved. Acetamiprid is now used as the reference component in monitoring of neonicotinoid resistance. Monitoring data on acetamiprid was tested in Sweden, Denmark and Lithuania in 2018-2021. For Scandinavia, data showed average mortalities above 90% in all years, while decreased susceptibility was observed in Lithuania.

A total of 27 population samples of cabbage seed weevils were tested according to IRAC Method 031 and classified according to susceptibility against λ-cyhalothrin. For the cabbage seed weevil, no control issues have been reported yet, but the data presented here, indicate that resistance may be emerging. More data in weevil susceptibility would be beneficial in coming years to get a better understanding of λ-cyhalothrin resistance status.

Acknowledgements

This report is composed of data from participants of the 2024 NORBARAG meeting.