Effects of insecticide applications primarily aimed at cabbage stem weevils (*Ceutorhynchus pallidactylus*) on the following abundances of pollen beetles (*Brassicogethes aeneus*) showing high resistance to pyrethroids

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Background:

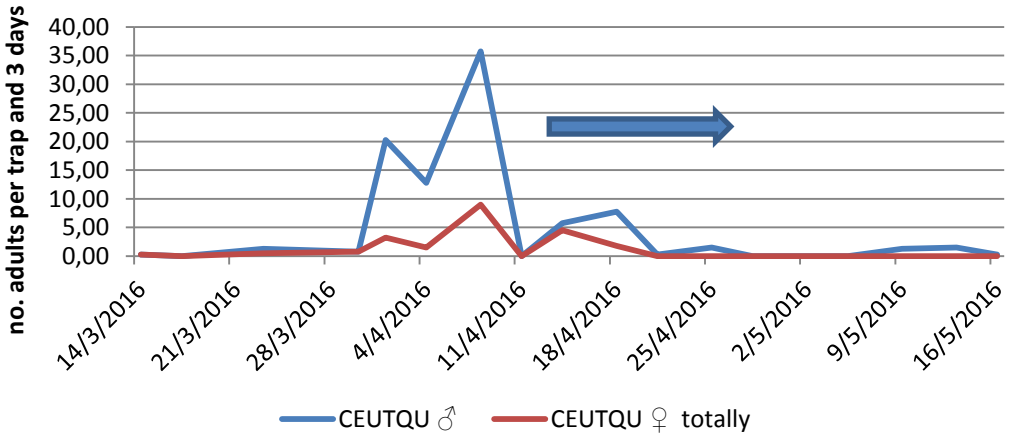
1) Approximately 300 thousand ha of winter oilseed rape crops are sprayed against stem weevils (*Ceutorhynchus napi* and *C. pallidactylus*) in the Czech Republic every year (usually one application; March/April; timing: profylactic and false in many cases).

2) The same acreage is sprayed against pollen beetles (*Brassicogethes aeneus*) every year (usually one or two applications; April and April/May; timing: according to national thresholds). RESISTANCE TO PYRETHROIDS; SHIFTS IN SUSCEPTIBILITY TO THIACLOPRID? Toxicity of insecticides for bees – limited number of avaiable active ingredients…

3) How to look at spring insect pests? Shall we perceive the **stem weevils – pollen beetles – pod midges** as:
   - temporally selected factors?
   - spatially selected factors?

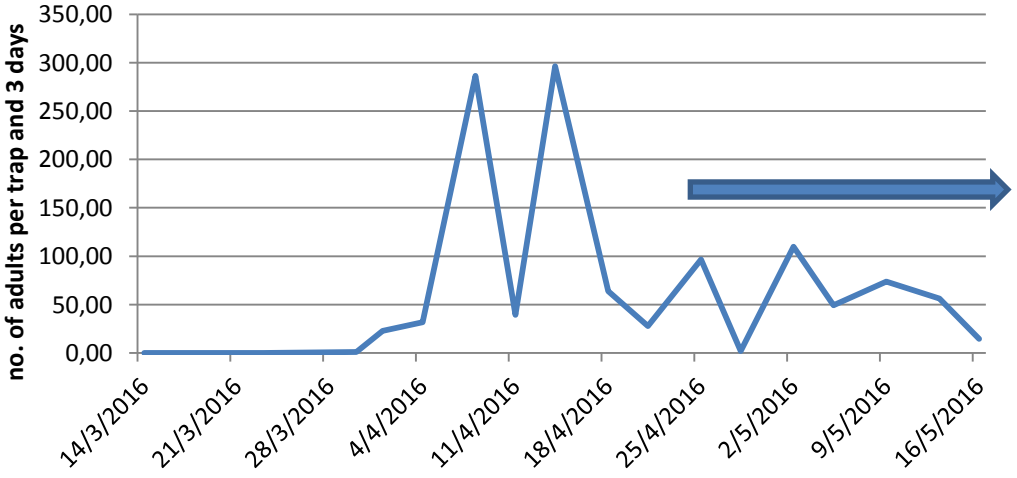
Are there any temporal and spatial associations among the spring insect pests (stem weevils, pollen beetles) in crops?

C. pallidactylus: fly activity (Rapotín 2016)

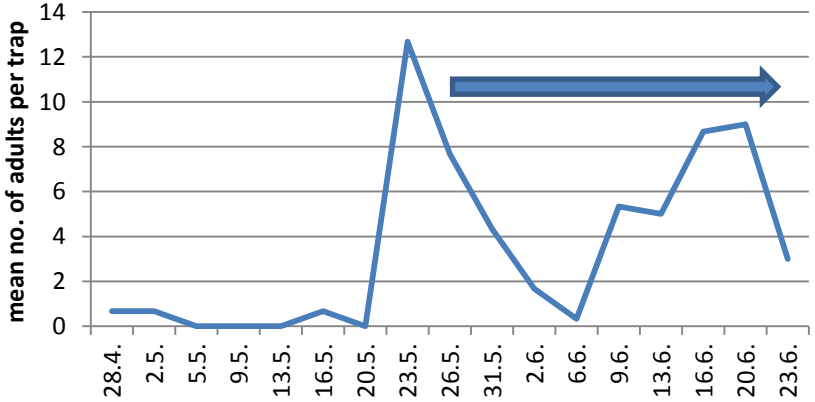


Their activities have some temporal development…

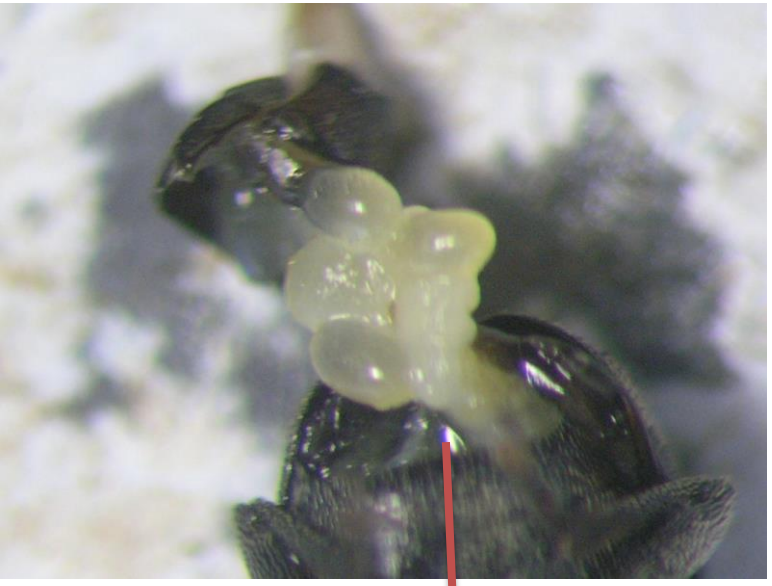
M. aeneus: fly activity (Rapotín 2016)

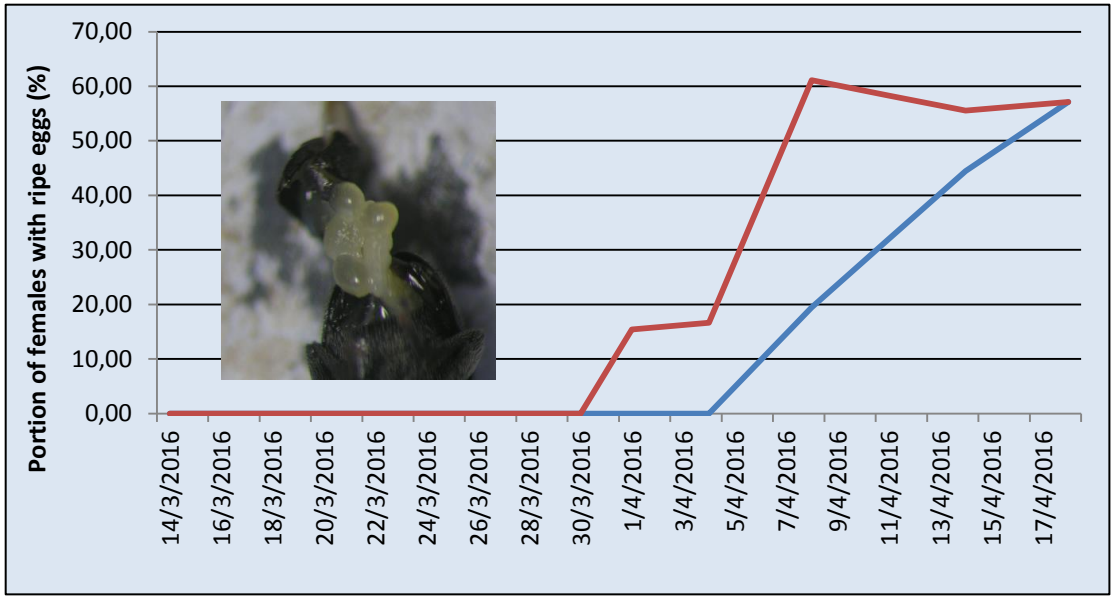


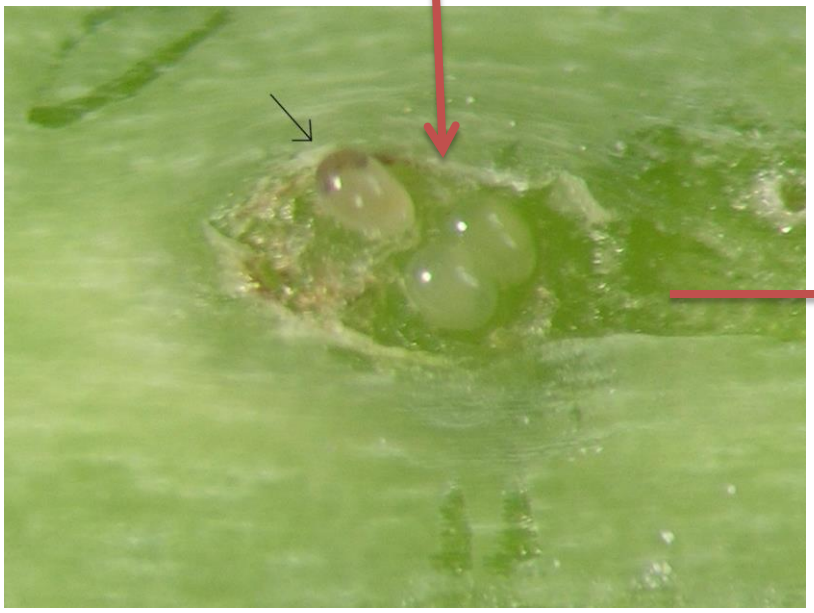
Fly activity of _D. brassicae_ in 2016



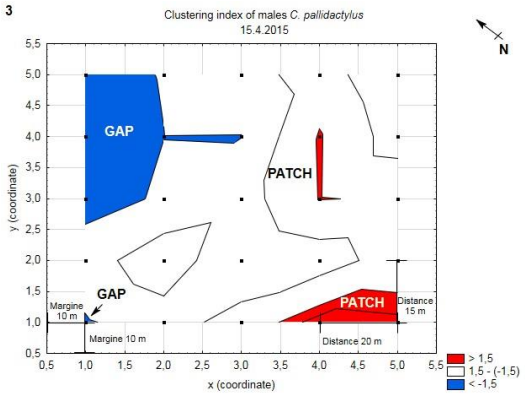
Beginning of egg-laying period for **stem weevils** is possible to state through the dissections of females catched in yellow water traps in the course of monitoring.

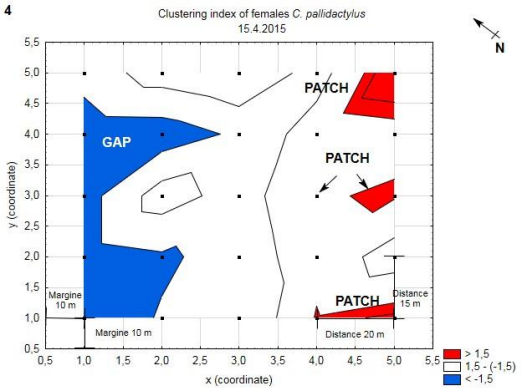


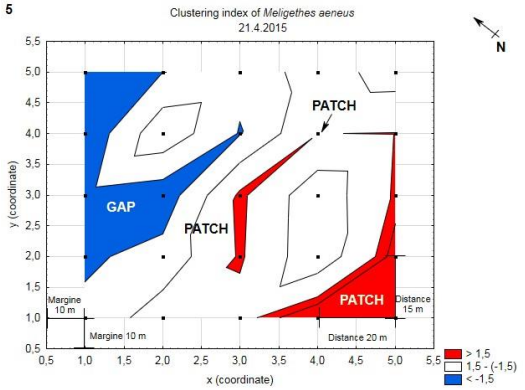


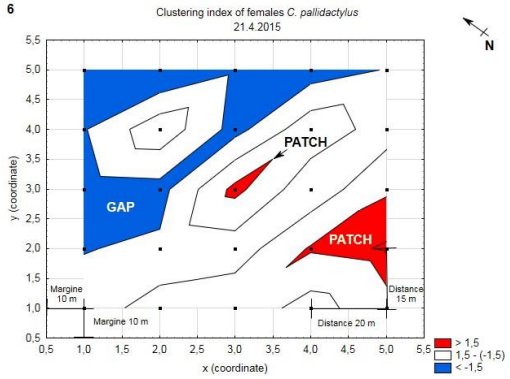


…and there are also some spatial associations among their distributions in the crops…







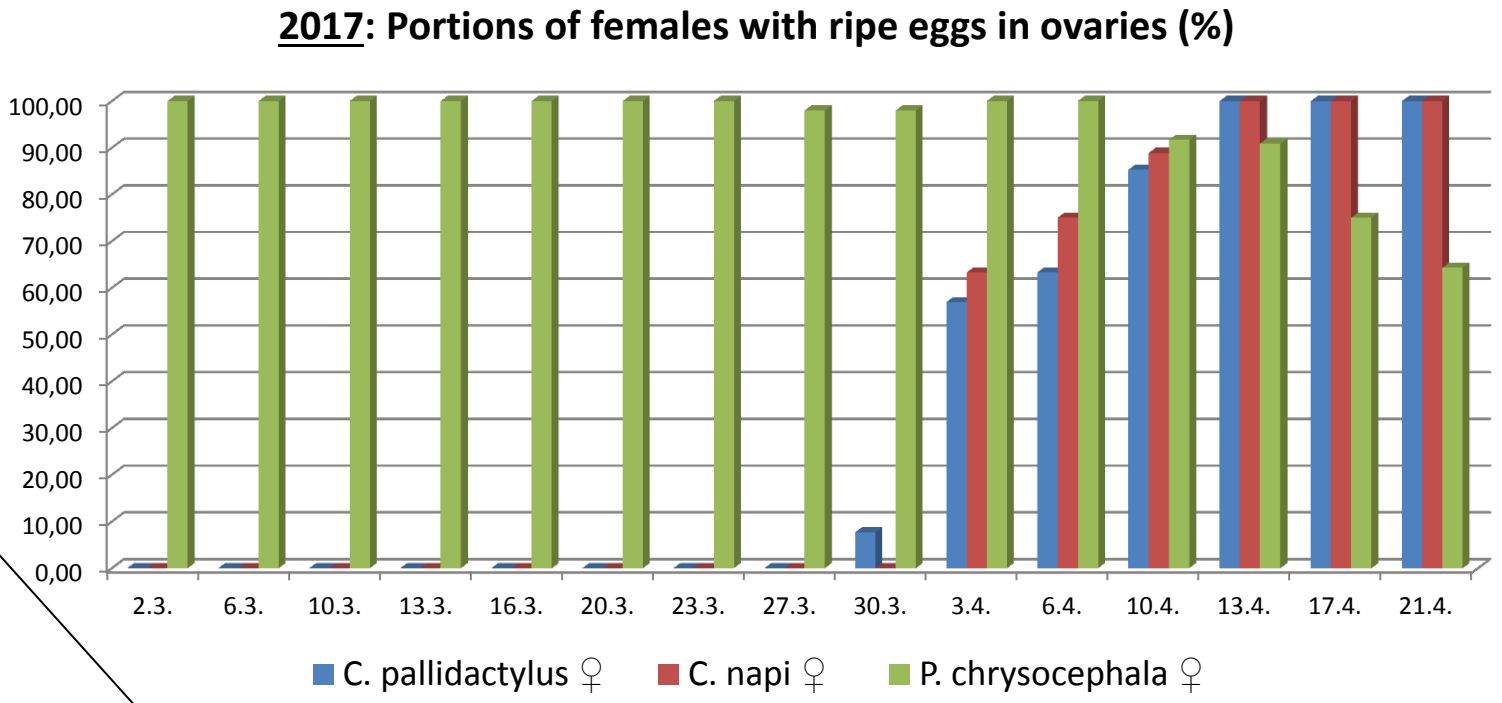


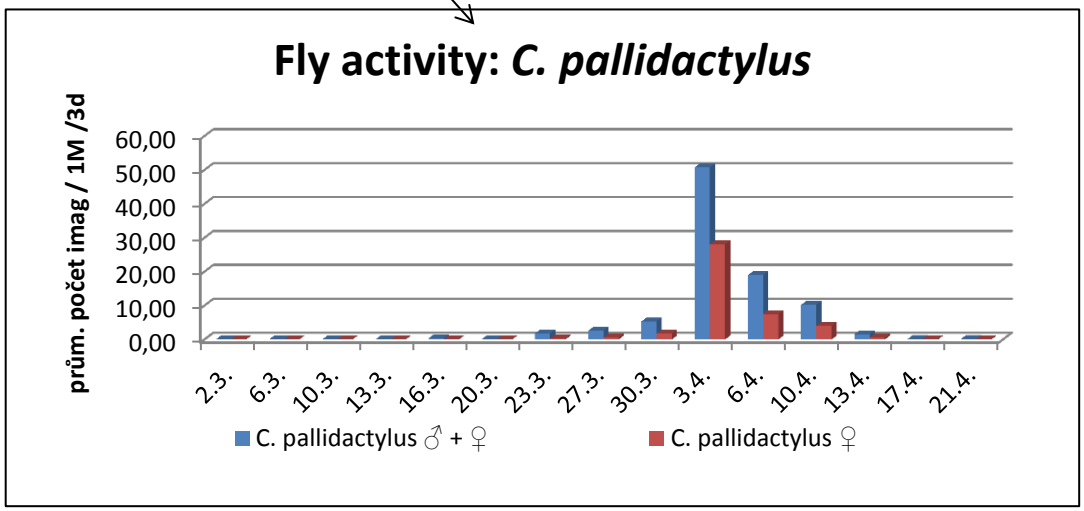
But this complicates monitoring in practice: How many traps? Exact monitoring = high consumption of time – farmers need service.

Date of sampling	rok	*C. pallidactylus* ♂ × ♀.		*C. pallidactylus* ♂ × adults *M. aeneus*		*C. pallidactylus* ♀ × adults *M. aeneus*	
		X	p	X	p	X	p
Σ	2013	**0.81***	**0**	**0.53***	**0.002**	**0.57***	**0**
Σ	2014	0.2	0.184	**-0.42***	**0.979**	0.34	0.09
Σ	2015	**0.71***	**0.001**	0.02	0.471	0.02	0.475

Distributions were analysed using SADIE analysis (Spatial Analysis by Distance IndicEs), for associations was used Quick association analysis.

What was the first insect pest prepared for egg-laying in 2017 (locality Rapotín, Czech Republic)





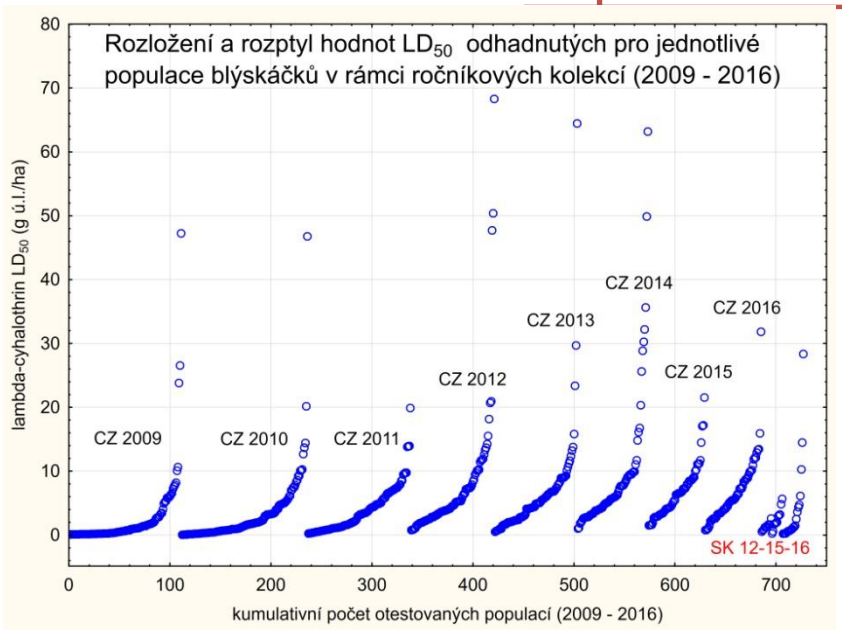
T. quadristriatus: pitfall traps - from March

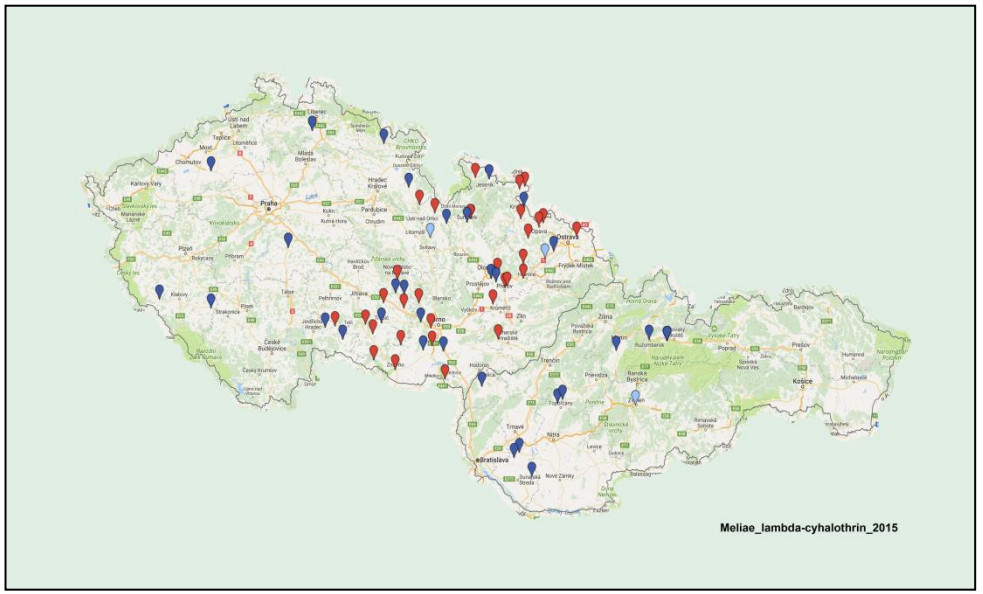
Ters. microgaster – active from April

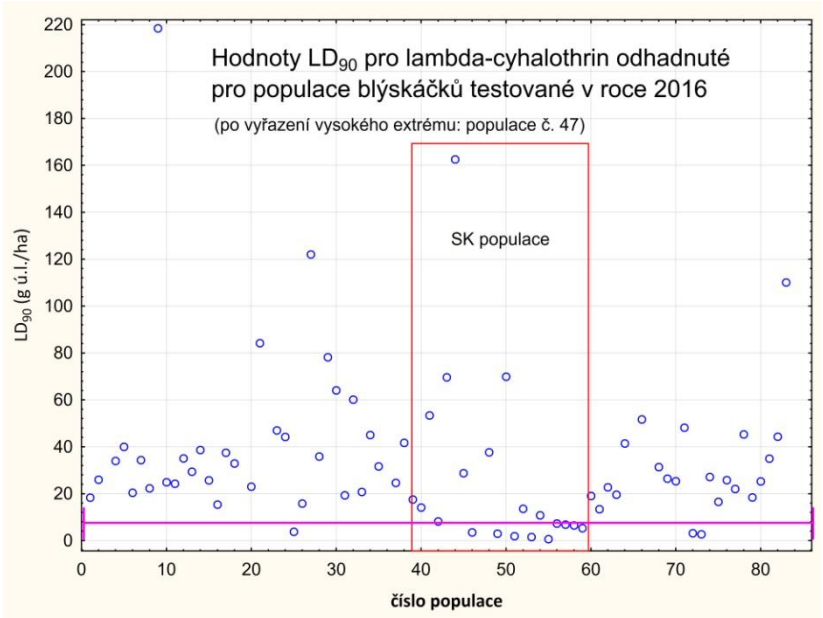
We try to answer several practical questions:

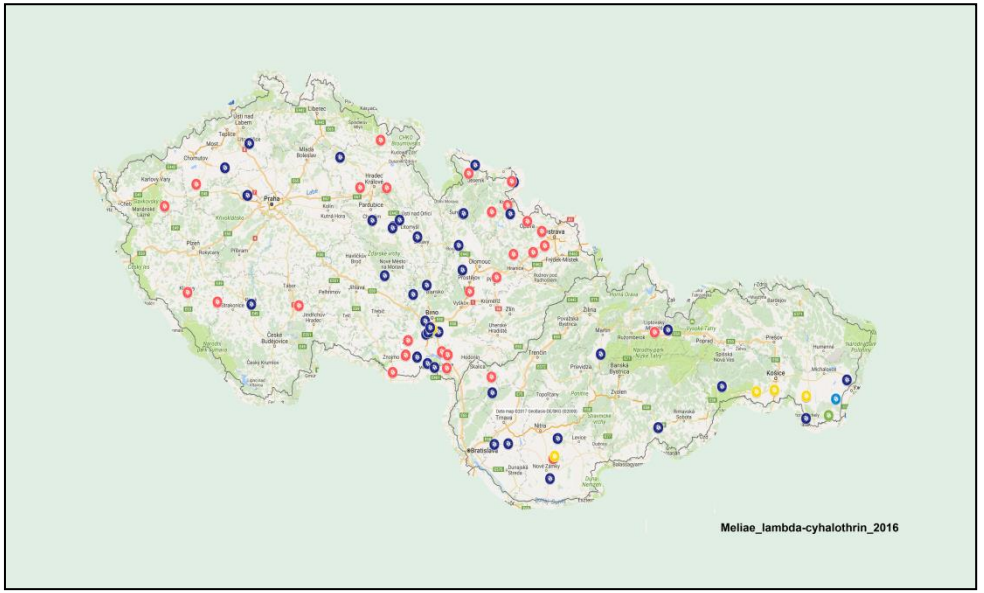
1) Can the exact and proper monitoring of cabbage stem weevils (and rape stem weevils) in crops bring any increase in quality of their control (in comparison with the contemporary practice)?
2) … and pollen beetles control at the same time?
3) Does the exact monitoring of stem weevils mean that the first spring application can be substantially delayed (to the time when pollen beetles are also present in the crop)?
4) What does the common application against stem weevils and pollen beetles mean for farmers at the time when pollen beetles show high levels of resistance to pyrethroids (and maybe also some shifts in susceptibility to neonicotinoids were recorded)?

Pollen beetles and their resistance to pyrethroids in the Czech Republic: lambda-cyhalothrin !!!







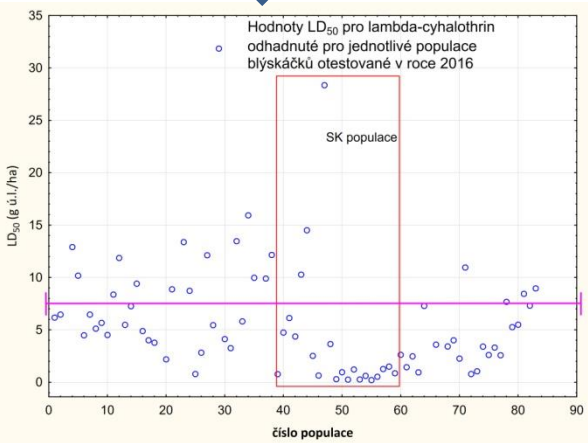


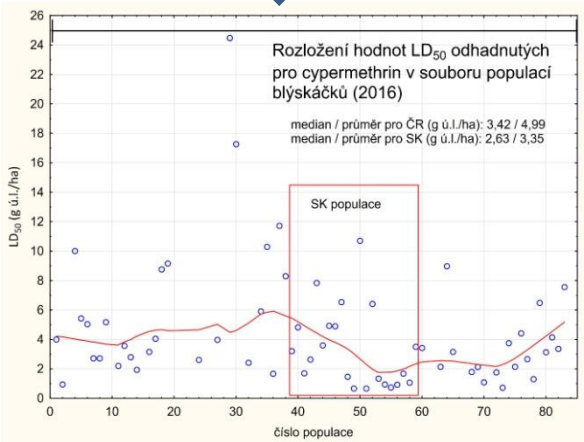
Relationships between LC_{50}, registered dose, lab. effectiveness of the registered dose and the resistance degree assigned to the individual populations according to IRAC guidelines

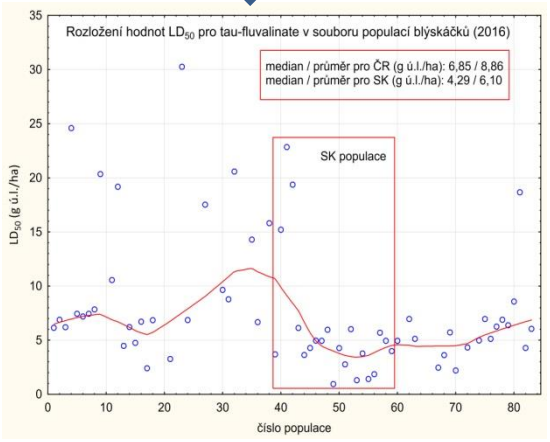
Lambda-cyhalothrin;
7.5 g a.i./ha

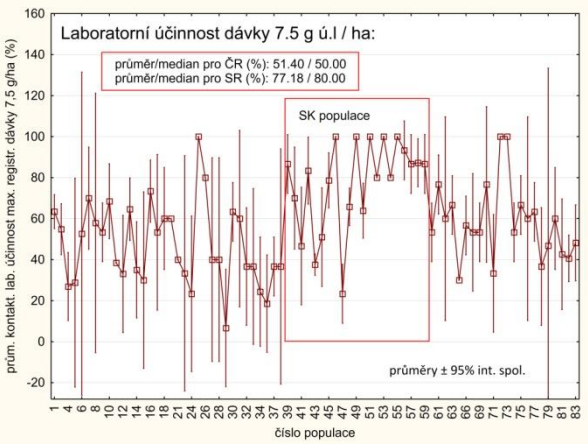
cypermethrin;
25 g a.i./ha

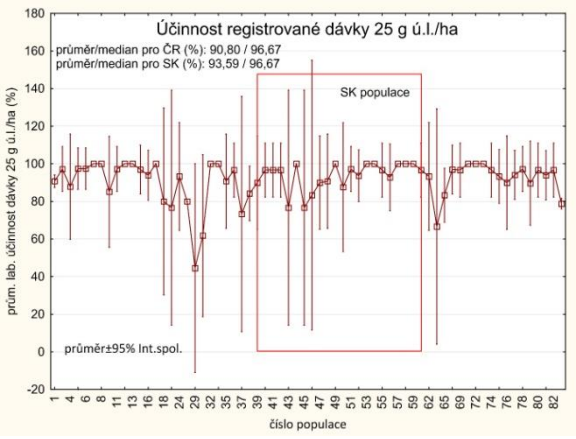
Tau-fluvalinate;
48 g a.i./ha

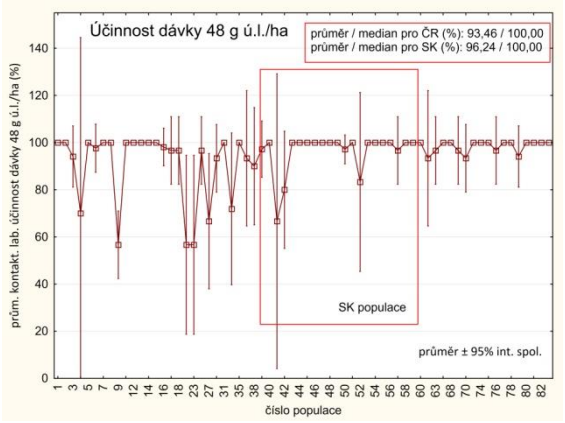




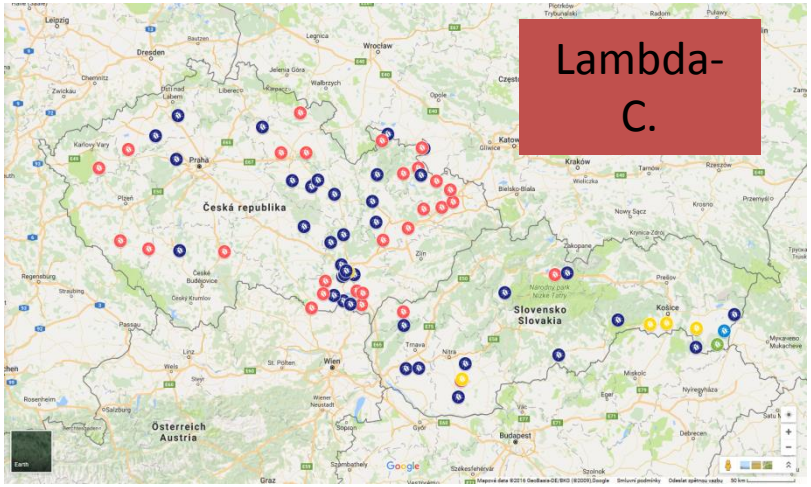


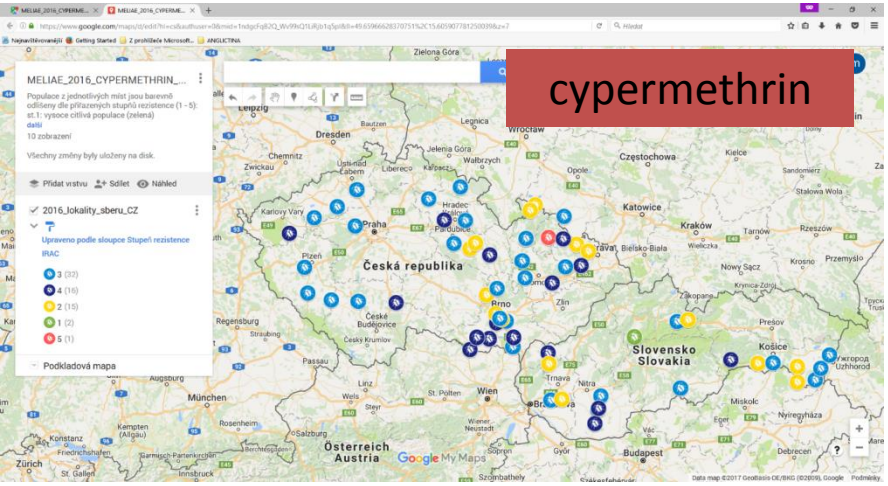






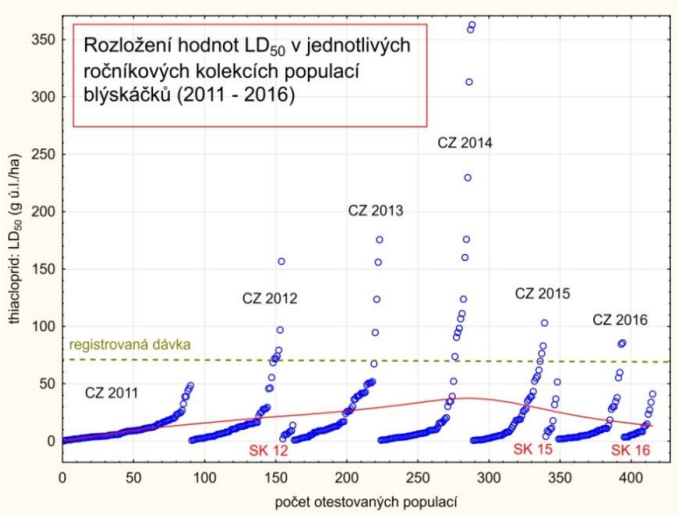
Relationships between LC_{50}, registered dose, lab. effectiveness of the registered dose and the resistance degree assigned to the individual populations according to IRAC guidelines





Is it possible to recommend pyrethroids (at least those which are registered in higher rates) to farmers for the common application against stem weevils and pollen beetles?

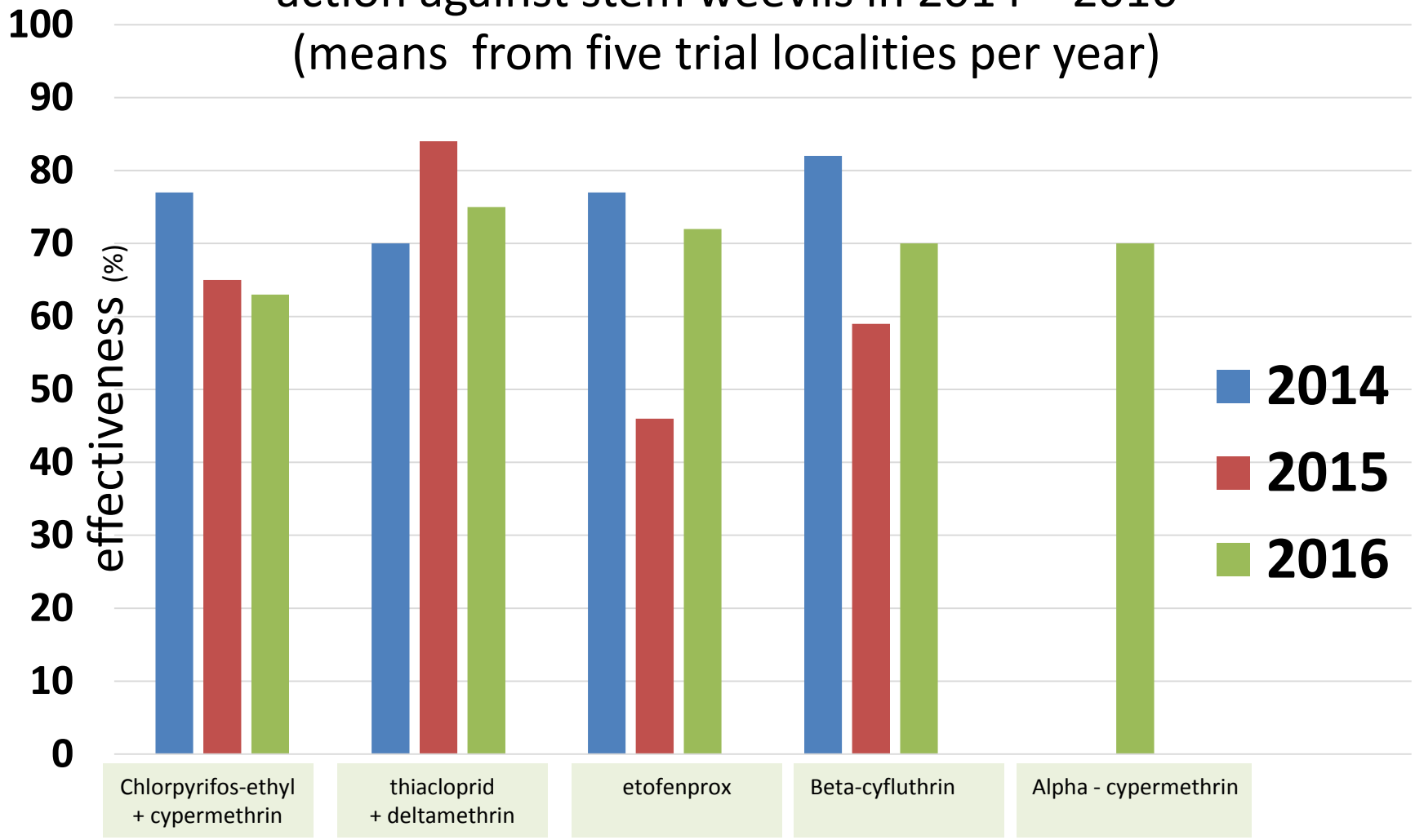
Pollen beetles: shifts in susceptibility of Czech populations to thiacloprid between 2011 and 2016 and positive correlations with lambda-cyhalothrin



Are neonicotinoids convenient alternative for pyrethroids?

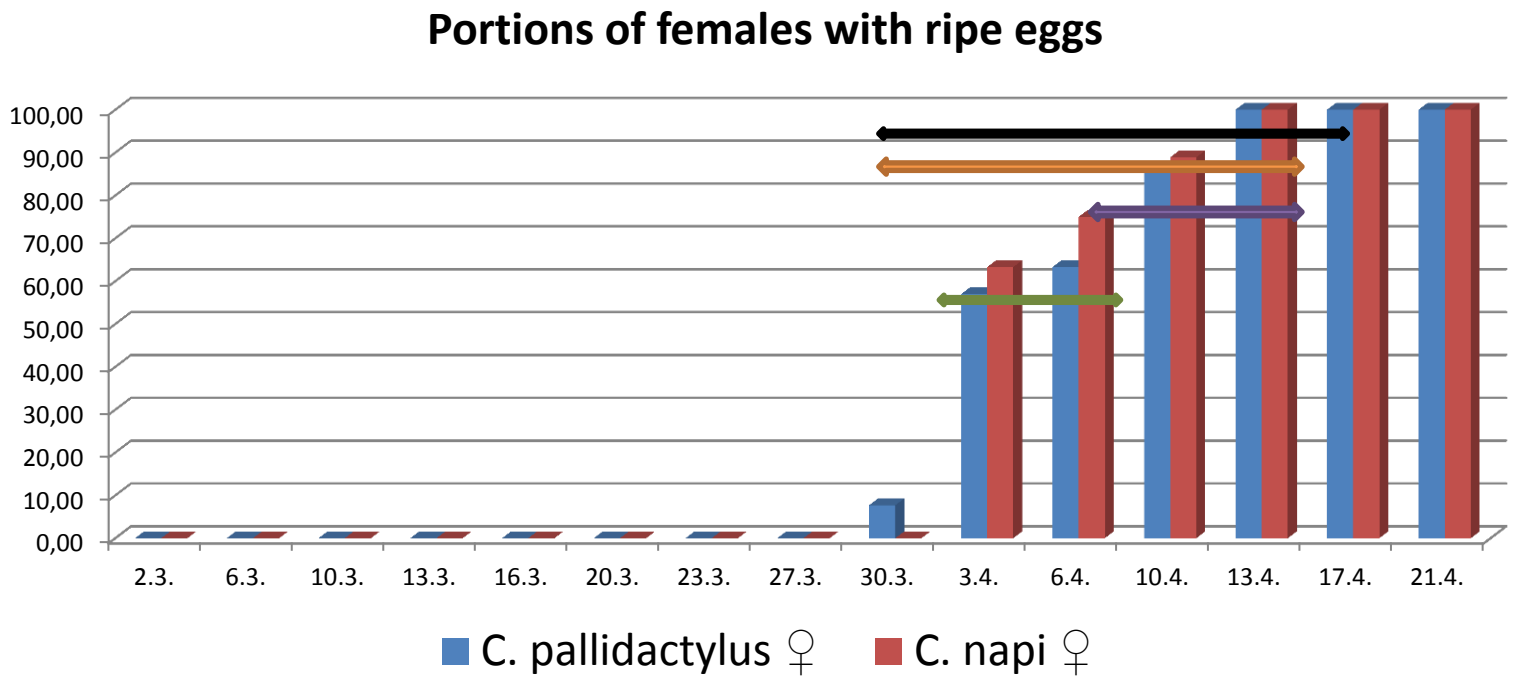
season	number of tested pairs	correlation analysis between **Log** values of:	Correlation coefficient **r**	Probability (p)
2011	86	LC_{50}	0.16	0.14
		LC_{90}	0.15	0.17
		LC_{95}	0.12	0.28
2012	68	LC_{50}	0.18	0.15
		LC_{90}	**0.39**	**0.001**
		LC_{95}	**0.40**	**0.001**
2013	60	LC_{50}	-0.10	0.46
		LC_{90}	0.03	0.82
		LC_{95}	0.05	0.70
2014	65	LC_{50}	**0.44**	**0.00**
		LC_{90}	**0.58**	**0.00**
2015	58	LC_{50}	0.18	0.18
		LC_{90}	**0.37**	**0.01**
		LC_{95}	**0.39**	**0.00**
2016	63	LD_{50}	-0.13	-0.20
		LD_{90}	-0.01	0.03
		LD_{95}	-0.01	0.08

Effects of insecticides with different modes of action against stem weevils in 2014 – 2016 (means from five trial localities per year)



Effects of pyrethroids are more variable more dependent on the date of application

Relationship between the time of application, portion of stem weevil females with ripe eggs and expected effectiveness of insecticides with different modes of action

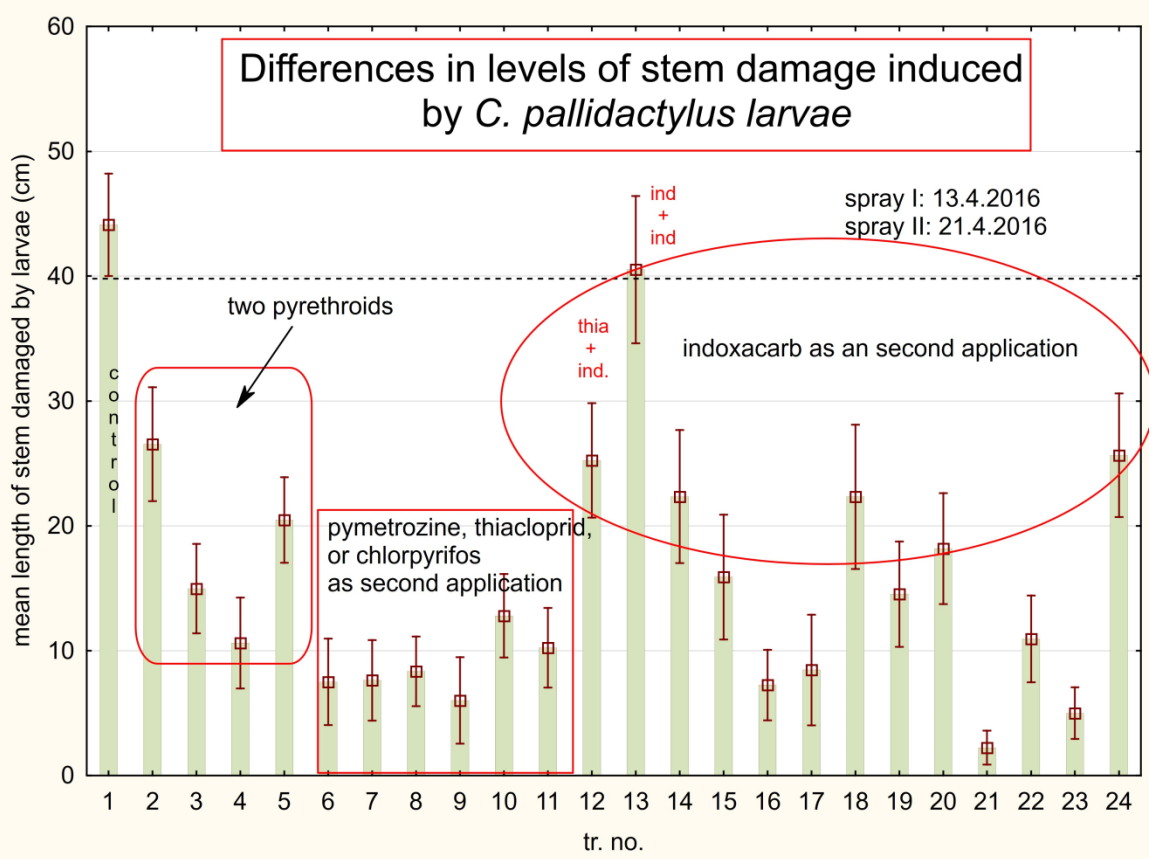


Application of OP and OP + pyrethroids can be delayed to the time when all females in traps are prepared for oviposition without decrease in their effectiveness on them

Neonicotinoids + pyrethroids and neonicotinoids solo – delay is possible

Pyrethroids solo – delay is not possible

Also the second spring application influences the levels of stem damage induced by *C. pallidactylus larvae*



indoxacarb	*C. napi*	*C. pallidactylus*	*B. aeneus*
lab. contact effect. of registered dose (25 g a.i. /ha; %)	63.38	68.26	100
mean LC_{50} (g a.i./ha)	14.28	15.64	1.00
mean LC_{90} (g a.i./ha)	75.35	73.56	3.15

Conclusions:

1) Spray timing based on dissection of female *C. pallidactylus* may delay the first spring insecticide application up until the advanced growth stages of winter oilseed crops (BBCH 53 - 57(59)) when above-threshold abundances of pollen beetles are normally found.

2) Insecticides with sufficient efficacy against both of these insect pests are needed for such applications.

3) Applications of organophosphates (chlorpyrifos-ethyl) and in combination with pyrethroids (chlorpyrifos-ethyl + cypermethrin) show high effectiveness against *C. pallidactylus*, when these insecticides are applied at the insect stage when the first females with ripe eggs are recorded to the stage when almost all females (90 %) have ripe eggs. The effects of these insecticides against pollen beetles is high and relatively long-lasting (above 80 % for at least 1 week).

Conclusions:

4) The highest effects of neonicotinoids (thiacloprid) and their combinations with pyrethroids (thiacloprid + deltamethrin) against *C. pallidactylus* are usually recorded when they are applied at the stage when almost all females (above 90 %) have ripe eggs. The simultaneous effects of neonicotinoids on pollen beetles are lower than effects of organophosphates but higher than effects of pyrethroids.

5) The egg-laying activity of *C. pallidactylus* can be long (April – June) and the second spring application can influence its course. The supplementary effects of chlorpyrifos-ethyl + cypermethrin, thiacloprid + deltamethrin, and pymetrozine were relatively high, the effects of indoxacarb were low.