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IMPACT OF A PYRETHROID INSECTICIDE APPLICATION ON GROUND BEETLES (*COLEOPTERA: CARABIDAE*) IN A WINTER RAPE STAND

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Abstract

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The effect of the application of insecticide FURY 10 EW (0.15 L ha^{-1}) in winter rape on non-target indicator ground beetles (Coleoptera: Carabidae) was examined in a field experiment. The species composition, the dominance structure, the abundance and the diversity of ground beetles in pitfall traps was compared before and after the application of the insecticide during April 2009. In total, 128 specimens of 19 species of ground beetles was recorded. The community was dominated by *Poecilus cupreus* (61% of total specimens) and it consisted of eurytopic carnivorous and granivorous species typical for intensively managed crop fields. No effect of the insecticide treatment on the community characteristics was observed. The Shannon diversity (*H'*) index was 1.5 and 1.6 before and after the insecticide application, respectively. The application of insecticide on well grown rape plants, which may have protected the soil surface from a contact with the insecticide, could be accounted for the leaving the ground beetles community intact.

insecticide, FURY 10 EW, winter rape, ground beetles, diversity

Intesticide treatment aimed on the protection against the insect pests, mainly pollen beetles *Meligethes aeneus* (Fabricius, 1775), has been commonly practised by the farmers in the rape stands. The impact of this treatment on non-target insects may be evaluated using the indicator insect groups (Holland *et al.*, 2000; Navntoft *et al.*, 2006). Among them, the ground beetles (Coleoptera: Carabidae) are suitable taxons due to their well known species-specific ecological valence and elaborating methodology of collecting and the determination (Holland and Luff, 2000; Šťastná and Bezděk, 2002; Heyer *et al.*, 2003; Horáková *et al.*, 2005; Šejnohová, 2006; Šafář *et al.*, 2010). The aim of this study was to examine the impact of an insecticide treatment on the species composition and structure of ground beetles in order to evaluate the impact of this management practice on the non-target organisms in a rape stand.

MATERIAL AND METHODS

The study was conducted in a winter rape field at Dynín near České Budějovice in the South Bohemia during April 2009. The rape plants were about 50 cm high at the beginning of the experiment and about 100 cm high at the end of the experiment. The experimental site neighboured to the field of a grown winter wheat in the west, it bordered to a paved road in the north, and continued as a winter rape field to other sides. Six rows of pitfall traps were placed in the rape field in eighteen meters distances, the first row being 40 meters from the wheat field in the west and the next rows being placed further in the east. In each row, the traps were layed in three groups, the first group being 30 meters from the paved road in the north and the other being one hundred meters from each other in the direction to the south. Three – two – three single traps scheme was used in each row in the three groups of traps.

The traps were formed by the 0.8 liter glass jars of 7 cm in diameter, which were partly filled with 100 ml of 5% formaldehyde solution.

The experimental field was treated with DAM 390 fertiliser (150 L ha^{-1}) and with Nurelle D insecticide (0.6 L ha^{-1}) two times before the beginning of the experiment, on April 13 and 17. The pitfall traps were placed in the field a day later (April 18). The beetles collected in traps were put out from the traps five days later (April 23; the first sampling period). At the same date the application of the insecticide FURY 10 EW aimed on the protection against the pollen beetle *Meligethes aeneus* was carried out. The FURY 10 EW is a highly effective pyrethroid acting as the contact and feed poison killing beetles, but also fish and water organisms, mainly the algae. The active substance is zeta-cypermethrin (100 gL^{-1}). The FURY 10 EW was applied in a mixture with fungicide ALERT S and water (0.15 L FURY + 1 L ALERT S + 160 L of water) aimed on treatment of one hectar of the field in 100% variant. The rows 1 and 2 were treated by this 100% variant, whereas 80% of this insecticide mixture volume per hectar was applied in rows 3 and 4, and only 50% of the mixture volume was applied in row 5 and 6. The insecticide was applied by the Hardi Commander Twin System equipment. The traps were re-placed in the same sites immediately after the application of this mixture and the collected beetles were taken from the traps five days later (on April 28, the second sampling period). During the experiment, the weather was sunny, the temperature during the daytime was between 17 and 25 °C, and no rain.

Species of the collected ground beetles were identified according to Hůrka (1996). The Shannon index of diversity (*H'*) was calculated according to Magurran (1988) and the species were sorted to ecological groups according to Hůrka *et al.* (1996).

RESULTS AND DISCUSSION

In total, nineteen species of ground beetles were recorded in the samples (Tab I). The composition of the species was typical for the intensively managed crop fields (Honěk and Jarošík, 2000; Krejčová and Bezděk, 2000; Krejčová *et al.*, 2000; Šťastná *et al.*, 2001; Purchart and Kula, 2005). The community was dominated by *Poecilus cupres*, which formed 64% and 60% of all collected specimens in the first and the second sampling period, respectively. The other common species were *Pseudophonus rufipes*, *Clivina fossor*, *Harpalus affinis* and *Amara aenea* (less than 13% species dominance in a given sampling period). Most of species appertained to eurytopic species (category E according to Hůrka *et al.*, 1996) without any specific requierements on the environmental conditions. Two species (*Amara lunicollis* and *Pterostichus diligens*) appertained to less eurytopic (adaptable) species (category A according to Hůrka *et al.*, 1996). The community was formed by the carnivorous species (*Poecilus* sp., *Clivina* sp., *Bembidion* sp., *Pterostichus* sp.), as well as by the granivorous species (*Pseudophonus* sp., *Harpalus* sp., *Amara* sp.). The rape seeds attract the granivorous

I: *List of species with their total abundance in traps and the category of their ecological valence. The species are listed according to their total dominance in the samples. E – eurytopic species, A – adaptable species (according to Hůrka et al., 1996).*

Species	Total	Ecological valence
Poecilus cupreus (Linnaeus, 1758)	78	E
Pseudophonus rufipes (DeGeer, 1774)	9	E
Clivina fossor (Linnaeus, 1758)	6	E
Harpalus affinis (Schrank, 1781)	6	E
Amara aenea (DeGeer, 1774)	4	E
Bembidion lampros (Herbst, 1784)	4	E
Amara similata (Gyllenhal, 1810)	3	E
Bembidion properans (Stephens, 1828)	3	E
Pterostichus melanarius (Illiger, 1798)	3	E
Amara familiaris (Duftschmid, 1812)	2	E
Clivina collaris (Herbst, 1784)	2	E
Acupalpus meridianus (Linnaeus, 1761)	1	E
Amara lunicollis Schioedte, 1837	1	A
Amara plebeja (Gyllenhal, 1810)	1	E
Anchomenus dorsalis (Pontoppidan, 1763)	1	E
Calathus melanocephalus (Linnaeus, 1758)	1	E
Harpalus distinguendus (Duftschmid,1812)	1	E
Poecilus versicolor (Sturm, 1824)	1	E
Pterostichus diligens (Sturm, 1824)	1	A
Total	128	

II: *The distribution of the species records between the rows (R1-6) and the groups of traps (1–18) in the first five-day sampling period (before insecticide treatment). Abbreviations of genera: A – Acupalpus, Am – Amara, B – Bembidion, C – Clivina, H – Harpalus, P – Poecilus, Ps – Pseudophonus, Pt – Pterostichus.*

	R1			R2			R3			R4			R5			R6		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A. meridianus	1																	
Am. aenea		1									1			1				
Am. similata		1																
B. lampros		3																
B. properans					1													
C. collaris			1					1										
C. fossor	1		1							1		1						
H. affinis			1									1						
P. cupreus	8	4	2	2	2		3	2		1		4		1		7	1	
P. versicolor														1				
Ps. rufipes							1											
Pt. melanarius			1				1											

III: *The distribution of the species records between the rows (R1-6) and the groups of traps (1–18) in the second five-day sampling period (following insecticide treatment). Abbreviations of genera: Am – Amara, An – Anchomenus, B – Bembidion, Ca – Calathus, C – Clivina, H – Harpalus, P – Poecilus, Ps – Pseudophonus, Pt – Pterostichus.*

	R1			R2			R3			R4			R5			R6		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Am. aenea					1													
Am. familiaris	1	1																
Am. lunicollis							1											
Am. plebeja			1															
Am. similata	1		1															
An. dorsalis					1													
B. lampros	1																	
B. properans			1	1														
Ca. melanocephalus							1											
C. fossor		1												1				
H. affinis	1		1				1				1							
H. distinguendus													1					
P. cupreus	7	1	2	3			2	4	3	1	2	2	8	1		4	1	
Ps. rufipes			2	1			1		1	1				1		1		
Pt. diligens			1															
Pt. melanarius							1											

species and the presence of these seeds on the ground surface may influence the distribution of the beetles in the field and among traps (Honěk and Jarošík, 2000). The spatial distribution of species records in particular sampling periods is given in Tab. II and Tab. III. No between-row preference was evident in the most abundant species (*Poecilus cupreus*, *Pseudophonus rufipes*, *Clivina fossor*, *Harpalus affinis*), although the less abundant species tended to be recorded more frequently in the 100 and 80% variant treatment rows than in the 50% variant treatment rows.

Three species were recorded only in the first sampling period (*Poecius versicolor*, *Clivina collaris*, *Acupalpus meridianus*), whereas other seven species were recorded only in the second sampling period (*Harpalus distinguendus*, *Amara familiaris*, *Amara lunicollis*, *Amara plebeja*, *Pterostichus diligens*, *Anchomenus dorsalis*, *Calathus melanocephalus*; Tab. IV). However, these species were recorded only in one or two specimens. The other, more abundant species were recorded in the traps both before and after the application of the insecticide. In total, 58 and 70 specimens were collected in the first and in the second sampling period, respectively. The Shannon index of diversity (*H'*) was 1.5 and 1.6 in the first and in the second sampling period, respectively. Thus, the insecticide treatment did not have any negative

IV: *The number of collected specimens in particular rows and sampling periods (A – before insecticide treatment; B – after insecticide treatment). The species are listed according to their total dominance in the samples. For the abbreviations of the genera see Tables II and III.*

Species	Period	Row						Total
		1	2	3	4	5	6	
P. cupreus	A	14	4	5	5	1	8	37
	B	10	3	9	5	9	5	41
Ps. rufipes	A	0	0	1	0	0	0	1
	B	2	1	2	1	1	1	8
C. fossor	A	2	0	0	2	0	0	4
	B	1	0	0	0	1	0	2
H. affinis	A	1	0	0	1	0	0	2
	B	2	0	1	1	0	0	4
Am. aenea	A	1	0	0	1	1	0	3
	B	0	1	0	0	0	0	1
B. lampros	A	3	0	0	0	0	0	3
	B	1	0	0	0	0	0	1
Am. similata	A	1	0	0	0	0	0	1
	B	2	0	0	0	0	0	2
B. properans	A	0	1	0	0	0	0	1
	B	1	1	0	0	0	0	2
Pt. melanarius	A	1	0	1	0	0	0	2
	B	0	0	1	0	0	0	1
Am. familiaris	A	0	0	0	0	0	0	0
	B	2	0	0	0	0	0	2
C. collaris	A	1	0	1	0	0	0	2
	B	0	0	0	0	0	0	0
A. meridianus	A	1	0	0	0	0	0	1
	B	0	0		0	0		0
Am. lunicollis	A	0	0	0	0	0	0	0
	B	0	0	1	0	0	0	1
Am. plebeja	A	0	0	0	0	0	0	0
	B	1	0	0	0	0	0	1
An. dorsalis	A	0	0	0	0	0	0	0
	B	0	1	0	0	0	0	1
Ca. melanocephalus	A	0	0	0	0	0	0	0
	B	0	0	1	0	0	0	1
H. distinguendus	A	0	0	0	0	0	0	0
	B	0	0	0	0	1	0	1
P. versicolor	A	0	0	0	0	1	0	1
	B	0	0	0	0	0	0	0
Pt. diligens	A	0	0	0	0	0	0	0
	B	1	0	0	0	0	0	1
Total		48	12	23	16	15	14	128

effect on the species composition, the abundance, the dominance structure, nor on the diversity of ground beetles. This could be accounted to the way of application on the well grown rape plants, which substantially protected the soil surface against the contact with insecticide (Vokoun, personal observation). The negative effect of an insecticide treatment applied directly on the soil on the ground beetles was recorded by Lee *et al.* (2001) in a maize field. In a winter wheat and in a winter rape stands the depression of abundancy of ground beetles was observed immediately after the application pyrethroids (Langmaack *et al.*, 2001; Beľskaya *et al.*, 2002) and it took several weeks before the carabid community reestablished in a state precedent to the insecticide treatement.

SUMMARY

The field experiment on the effect of the application of insecticide FURY 10 EW (0.15 L ha^{-1}) in winter rape on non-target indicator ground beetles (Coleoptera: Carabidae) was conducted in the South Bohemia in April 2009. In total, 128 specimens of 19 species of ground beetles were recorded. No significant effect of the treatment on the species composition, the dominance structure, the abundance in traps and the diversity of ground beetles was observed. The Shannon diversity (*H'*) index was 1.5 and 1.6 before and after the insecticide application, respectively. The application of insecticide on well-grown rape plants was probably the reason why the ground beetles community rested intact after the treatment.

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