Current status of resistance level in pollen beetle (*Meligethes aeneus* F.) and cabbage seed weevil (*Ceutorhynchus assimilis* Payk) to selected active substances of insecticides in Poland

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INTRODUCTION

Pollen beetle (*Meligethes aeneus* F.) and cabbage seed weevil (*Ceutorhynchus assimilis* Payk) are the most serious pests of oilseed rape in Poland in recent years. The economic damage threshold of pollen beetle is exceeded every year on the whole area of Poland. In the past, the economic threshold of cabbage seed weevil was exceeded locally and the pests' populations not always required chemical treatment. However in recent years the significance of this species is becoming more and more important. The same active substances, belonging to the same chemical groups are recommended in Poland for the control of both pests. Nowadays, in Poland, there are 14 active substances recommended for pollen beetle control and 11 active substances recommended for cabbage seed weevil control. Details are presented in table 1.

Later treatments against pollen beetle exert selective pressure also on cabbage seed weevil. Applying insecticides for many years influenced the fact that nowadays both species show different resistance levels to the same active substances recommended in Poland for their control. This situation makes it necessary to monitor the pests' susceptibility levels constantly. The work presents research data on susceptibility levels of both species to the same, selected active substances.

Table 1. Insecticides recommended in Poland for pollen beetle and cabbage seed weevil control

Active substance	**Pollen beetle**	**Cabbage seed weevil**
Pyrethroids		
Alpha-cypermethrin	X	X
Beta-cyfluthrin	X	X
Bifenthrin	X	X
Cypermethrin	X	
Deltamethrin	X	X
Esfenvalerate	X	X
Etofenprox	X	X
Gamma-cyhalothrin	X	
Lambda-cyhalothrin	X	X
Tau-fluvalinate	X	X
Zeta-cypermethrin	X	X
Neonicotinoids		
Acetamiprid	X	X
Tiacloprid	X (with deltamethrin)	X (with deltamethrin)
Organophosphates		
Chlorpyrifos	X (with alpha-cypermethrin)	

MATERIAL AND METHODS

Tested insecticides (concentrations in ppm were calculated assuming that 200 litres of water is used per hectare):

pyrethroids:

deltamethrin: recommended concentration for pollen beetle 25 ppm and for cabbage seed weevil 37.5 ppm

zeta-cypermethrin: recommended concentration for pollen beetle and cabbage seed weevil 50 ppm

tau-fluvalinate: recommended concentration for pollen beetle and cabbage seed weevil 240 ppm

neonicotinoids:

acetamiprid: recommended concentration for pollen beetle and cabbage seed weevil 120 ppm

organophosphates:

chlorpyrifos: recommended concentration for pollen beetle 1440 ppm

In laboratory tests the standard method recommended by Insecticide Resistance Action Committee (IRAC method nr.7) was used. Accurate demineralised water dilutions of tested active substances from commercially-available products were used in the selected doses expressed in parts per million (ppm). Rape inflorescences were dipped in the various test concentrations of insecticides for about five seconds, then placed on a dry filter paper towel to dry. Untreated and treated dry plant material was placed into 0.9 l jars and 100 pollen beetles or 50 cabbage seed weevils were placed in each jar. Three replicates were conducted for each concentration and the control. A final assessment - lethal effects of the active substance of the insecticides was determined after 24 hours of application and expressed as percent mortality of insects at each dose, relating to untreated (control) mortalities using Abbott's formula, if needed. At each assessment, beetles were classed as either: (a) unaffected, giving a normal response (such as taking a coordinated step), (b) dead or affected, giving an abnormal response to stimulation. Tests were performed in laboratory conditions: 20–22°C and photoperiod of 16:8 (L:D). Lethal concentrations LC50 and LC95 were calculated using computer program based on Finney probit analisys method and expressed in ppm concentration of active substance.

RESULTS AND DISCUSSION

Table 2. The range of susceptibility level of different Polish pollen beetle and cabbage seed weevil populations to selected insecticides, expressed as LC50 and LC95 concentration of active substance (expressed in ppm)

Active substance	Recommended concentrations [ppm] pollen beetle / cabbage seed weevil	Years	LC50 (minimum–maximum)		LC95 (minimum–maximum)	
			pollen beetle	cabbage seed weevil	pollen beetle	cabbage seed weevil
Acetamiprid	120 / 120	2008–2010	6–60	80–250	130–900	400–5200
Chlorpyrifos	1440 / –	2008–2010	0.1–3	1.5–8	0.7–16	7–36
Deltamethrin	25 / 37.5	2009–2010	20–50	0.02–0.15	100–800	0.2–1.1
Zeta-cypermethrin	50 / 50	2009–2010	35–60	0.02–0.2	130–220	0.5–1.8
Tau-fluvalinate	240 / 240	2008–2009	15–100	11–50	140–600	90–280

Pollen beetle

1. All investigated populations of pollen beetle showed some level of resistance to examined pyrethroid active substances. The toxicity of all tested pyrethroids against pollen beetle was similar. However taking into consideration recommended concentrations, the highest resistance was noted for deltamethrin (maximal resistance was 32x). Maximal resistance for zeta-cypermethrin was 4.4x. Resistance of pollen beetle to tau-fluvalinate was much lower (maximal resistance was 2,5x) and sometimes no resistance was recorded.
2. In case of acetamiprid, much higher mortality was usually recorded, although one population, when considering the recommended dose, revealed the resistance of 7.5x.
3. The examined active substance of organophosphorous insecticides – chlorpyrifos showed highly different influence upon pollen beetle. Chlorpyrifos caused 100% mortality of pollen beetle, even in very low concentrations – over 90 times lower than the highest recommended concentration.

Cabbage seed weevil

1. On the contrary to pollen beetle, cabbage seed weevil showed very high susceptibility to all tested pyrethroid active substances. Deltamethrin and zeta-cypermethrin showed very hjgh toxicity against this species. No case of resistance was recorded. In case of tau-fluvalinate, in several populations, very low level of resistance was recorded.
2. In case of acetamiprid, survival of cabbage seed weevil beetles achieved high levels at doses higher than the commercially recommended concentration. Resistance level ranged from 3.3 times to 43.3 times.
3. Researches showed sufficient effectiveness of chlorpyrifos against cabbage seed weevil. Toxicity of chlorpyrifos was similar, although a little lower than in case of pollen beetle