MANAGEMENT STRATEGY FOR COLORADO POTATO BEETLE (*LEPTINOTARSA DECEMLINEATA Say.*) IN POLAND

PLANT PROTECTION INSTITUTE

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Authors:

Pawel Wegorek – **Plant Protection Institute, Poznan**

Maria Pawinska – Plant Breeding and Acclimatization Institute Dept. in Bonin

Elzbieta Prybysz – Institute or Organic Industry, Warszawa

Robert Dutton – Dow Agro Sciences, U.K. – Insecticide Resistance Action Group

John Harris – Zeneca Agrochemicals, U.K. – Insecticide Resistance Action Group

C O N T E N T S

I. INTRODUCTION

Management of Colorado Potato Beetle (PBD) in Poland is mainly based on insecticide use. The very extensive acreage of potato cultivation (in the 90s, *ca* 1,600-1,700 ml ha) and the constant need for intensive chemical protection is due to the concentration and size of the CPB populations that considerably exceed the economic damage threshold in occurrence area. Nearly 50 years of constant selective pressure on the CPB has brought about the development of local populations with lower susceptibility to some insecticides. This phenomenon, known as resistance, resistivity or tolerance, leads to big losses in potato crop and restriction in use and sales of less effective insecticides. In Poland, resistance proved highest with the organophosphate, Enolofos 44 EC (the present name – Enolofos 500 EC), containing chlorfenvinphos as the biologically active ingredient. Resistance also appeared earlier, though on a lesser scale, in the case of chlorinated hydrocarbons insecticides – DDT, lindane, methoxychlor and the carbamates – carbaryl and propoxur. At present populations with increased tolerance to insecticides from the pyrethroids group and nereistoxin analogue can be observed. Problems caused by the pest's growing resistance usually result from an inappropriate and simplified way of applying the chemicals, with successive applications being carried out in a given area using one or more products, of the same class. Study of resistance mechanisms show that selection based on one factor only, after a period of time leads to development of genetically inherited features in the target populations, which allows individuals carrying those genes to survive the action in ever bigger numbers. Colorado Potato Beetle is a species with a very high natural resistance to all kinds of poisons and tolerates well both plant toxins and synthetic insecticides, and for this reason only a limited number of chemical compounds can be effectively used to fight it. In the years 1994-1997, following a commission of IRAC, monitoring of the susceptibility level of a large number of population of CPB was carried out in Poland in different regions of the country, the target being insecticides' biologically active ingredients – Bancol 50 WP, Sherpa 10 EC and Enolofos 500 EC. The study revealed a high degree of susceptibility variation to each of the insecticides both in the one and the same areas, and in regions geographically distant. This speaks of an advanced selection, which in near future may lead to development in the CPB of high resistance to each of the biologically active ingredient under investigation. To combat this situation, a

controlled and rational use of the management insecticide is necessary in Poland, following the strategy worked out by Polish research institutes in co-operation with IRAC.

II. FACTORS INFLUENCING RESISTANCE DEVELOPMENT IN COLORADO POTATO BEETLE

There are a number of factors that influence the insect's resistance. Genetic, biological, ecological and agrotechnological ones play a major role.

In the case of genetic factors, the genetic potential of the species is of considerable importance. In European CPB populations chemical selection factor decrease susceptibility, after several generations, with development of high resistance in a short period of time.

In Polish conditions, bio-ecological factors that influence resistance development also seem to favour CPB. This is determined by population concentration, fertility, length of larval growth, diapause occurrence, migration capability and variation in ecological conditions as well as too low natural selection.

Agrotechnological factors include the intensity of insecticide selective pressure (in Poland, there are on average 1.2-1.6 applications per year over almost total potato acreage, since every year the economic damage threshold is overshot), the life stage of the target pest, the level of mortality achieved, the way of application and the type of the used product.

III. PHYSIOLOGICAL MECHANISMS OF COLORAO POTATO BEETLE RESISTANCE

The main mechanisms that cause resistance of the CPB to insecticides are the following:

- increased metabolism of biologically active ingredient by specific detoxicating enzymes
- limitation of biologically active ingredient penetration through body coats (cuticula)
- excretion increase
- reduction of the nervous system susceptibility on the spot of insecticide action
- avoidance of areas treated with a chemical product.

IV: LIST OF INSECTICIDES FOR COLORADO POTATO BEETLE MANAGEMENT RECOMMENDED IN POLAND

(9 groups containing 40 preparations)

Group	Brand name	Dose in l kg.tab/ha	Optimal action Temp °C	PHI In days
Bacillus thuringiensis	Novodor 02 SC	3-5	Over 18	
Chloronicotinyls	Mospilan 20 SP	0,06-0,1	No influence	
Aryl propyl ethers	Trebon 10 EC	0,45-0,6	Over 15	1
	Trebon 30 EC	0,3	Over 15	1
Phenyl pyrazoles	Regent 200 SC	0,1	No influence	1
Organophosphates	Chlomezyl 500 EC	1-1,5	Over 15	3
	Cotnion – Metyl 200 EC	1,5-2	Over 15	
	Danacap 450 CS	1-1,5	Over 15	4
	Danadim 400 EC	1	Over 15	2
	Enolofos 500 EC	0.5-0.75	Over 15	1
	Hostation 40 EC	0,9	Over 15	1
	Terraguard 480 EC	0,5-0,7	Over 15	3
	Zolone 350 EC	1,5-2	Over 15	1
Chitin synthesis inhibitors	Andalin 250 DC	0,25-0,3	Over 18	
	Ekos 100 EC	0,25	Over 18	
	Mat 050 EC	0,3	Over 18	
	Nomolt 150 SC	0,2-0,25	Over 18	1
Carbamates	Marshal 250 DC	1-1,5	Over 15	
	Oncol 200 EC	0,6-1	Over 15	3
	Propxan 500 WP	0,6-1	Over 15	
Nereistoxin analogues	Bancol 50 WP	0,3-0,4	From 10 to 35	
Pyrethroids	Alfamor 050 SC	0,2	Below 20	
	Alfazot 050 EC	0,2	Below 20	
	Alphaguard 10 EC	0,08-0,1	Below 20	
	Ammo 250 EC	0,1-0,12	Below 20	1
	Bulldock 025 EC	0,2-0,3	Below 20	

Group	Brand name	Dose in l kg.tab/ha	Optimal action Temp °C	PHI In days
	Cyperkil 25 EC	**0,1-0,12**	**Below 20**	1
	Decistab TB	**8-12 tab**	**Below 20**	
	Decis 2,5 EC	**0,2-0,3**	**Below 20**	
	Fastac 10 EC	**0,08-0,1**	**Below 20**	
	Fury 100 EC	**0,1**	**Below 20**	1
	Karate 0,25 EC	**0,2-0,3**	**Below 20**	
	Ripcord 10 EC	**0,25-0,3**	**Below 20**	1
	Ripcord Nowy 0,50 EC	**0,2**	**Below 20**	
	Sherpa 10 EC	**0,25-0,3**	**Below 20**	1
	Sumi-Alpha 050 EC	**0,2-0,25**	**Below 20**	1
	Sumicidin 20 EC	**0,3-0,4**	**Below 20**	
+5 Pyretroids +	**Decisquick 425 EC**	**0,3**	**From 15 to 30**	
phosphorganic	**Nurelle D 550 EC**	**0,4-0,6**	**From 15 to 30**	3
+7 Pyretroids +	**Judo 150 EC**	**1**	**From 10 to 25**	
carbamates				

V. MECHANISMS OF INSECTICIDE ACTION ON COLORADO POTATO BEETLE

A majority of CPB insecticides registered in Poland affect the pest's nervous system. Carbamates and phosphorganic compounds block the action of acetylcholinesterase – an enzyme responsible for the decomposition of the neuro-transmitter – acetylcholine. Pyretroids block the sodium channels in the insect's neurons, causing first overexcitation of the nervous system and then paralysis of the insect. The nereistoxine analogue and chloronicotines acts an agonist of the nicotynic acetylocholine receptor – obstruct the activity of acetylcholine by interaction with the proteins receptors of the transmitter. Phenyl pyrazoles affect the receptor of another neurotransmitter – gamma aminobutyl acid (GABA). Insecticides of the chitin biosynthesis inhibitors group obstruct chitin biosynthesis in CPB larvae. They also affect females laying eggs, causing anatomical damage to the hatching larvae. Their biologically active ingredients interact with metabolites and block the enzymes responsible for chitin formation in the epithelium cells. The biologically active ingredients of the bacteria group products is in the form of crystals of active protein of the bacterium *Bacillus thuringiensis* subsp. *Tenebrionsis*, which damage the beetle's digestive system, mainly in its middle section, by disintegrating the cells.

Thus, insecticides for CPB control in Poland are classified in to **9 groups,** two of which clearly predominate in this country, these are pyretroids and the nereistoxine analogue. As much as 80-90% of pest management action in Poland involves Bancol 50 WP, Decis 2,5 EC, Fastac 10 EC and Karate 025 EC. If this tendency to apply only two of the above chemical classes continues, it may in effect increase the risk of resistance development in local CPB populations to the products belonging to these classes. The studies in resistance management carried out in research institutes (Instytut Ochrony Roslin in Poznan, Instytut Hodowli i Aklimatyzacji Roslin – Bonin Branch, Instytut Przemyslu Organicznego in Warszawa) have shown a highly diverse susceptibility of the monitored beetle populations to biologically active ingredients of three insecticides. Since in one growing season potato beetle usually produces only one complete generation, and on average 1.5 applications are used on it, there is small risk of a fast development of high resistance to a given biologically active ingredient or a chemical group over a few seasons. However, a continual selection pressure with similar product must be avoided, and insecticides from different chemical classes and with different mechanisms of action should be used.

VI. POTATO CROPS PROTECTION STRATEGY FOR PREVENTING CPB RESISTANCE DEVELOPMENT TO RECOMMENDED PRODUCTS

1. One of the main tools against resistance should to be constant monitoring of the pest's susceptibility level, using standard methods recommended by IRAC. Monitoring has allowed re-introduction of Enolofos 500 EC, withdrawn earlier from the western regions of Poland, because of CPB resistance. Resistant populations often show less adaptation and vitality (lower fertility, shorter life span *etc*). Following the withdraw of a selection factor, after a period of time the interbreeding of individuals from different populations can dilute the resistance gene pool and bring back high susceptibility to the given factor.

2. It is recommended that the products are applied in the full effective dose rates recommended by the producer. Too small doses (sublethal) quickly select populations with average level of tolerance, while too large ones lead to resistance development at a very high level. Thus, the choice of appropriate apparatus and the technique of application (correct amount of water, suitable liquid pressure for uniform spray coverage optimal temperature, *etc*) is of vital importance.

3. Timing of the application must coincide with moment of the greatest susceptibility in the life stage of the pest to the particular product. Application to young larvae can be more effective then on later stages or adults.

4. In case of using insecticide mixture, ensure that mixture compounds belong to different classes and are applied in effective equivalent control rates. The CPB can develop tolerance to components of the insecticide mixture, if it has been used long enough, and the resultant resistance may be more permanent and more difficult to manage than one developed separately to each of the biologically active ingredient present in the mixture.

5. If the action proves ineffective and must be repeated, the reasons of ineffectiveness must be defined and, if necessary, a product of different class should be used. IRAC method nr. 7 can be used to investigate potential resistance.

6. If the local Colorado beetle population has been found to be resistant to compounds of some specific class, products with similar action mechanism should not be used in the rotation strategy.

7. Withholding the use of the product that the CPB has developed resistance to must be continued until the pest shows high susceptibility.

8. Attention must be paid to protection of beneficial organisms – natural enemies of CPB, since these play a major role in the management of resistance. They limit the CPB population, irrespective of the pest's resistance and act against the selection of resistant population.

Aware of the fact that in Poland the choice of an insecticide for farm protection is mainly based on price, speedy effectiveness, ease of application, the pre-harvest interval and toxicity, we encourage farmers to follow the strategy outlined in this paper. Also, we recommend the use of unconventional products with new modes of action (Novodor 02 SC, Andalin 250 DC, Ekos EC, Mat 050 EC, Nomolt 150 SC) which, even if less popular because of their price, are highly effective when appropriately used, while one of their greatest advantages is environment protection and the safety of the user.

The strategy presented in this paper aim is extending the effective performance of all products recommended for control of the CPB in Poland.