ECOLOGICAL CONTROL METHODS AGAINST COLORADO BEETLE OF POTATO CROPS ACCORDING TO ENVIRONMENTAL REQUIREMENTS

METODE DE COMBATERE ECOLOGICĂ A GÂNDACULUI DIN COLORADO DIN CULTURA DE CARTOF, ÎN CONTEXTUL ARMONIZĂRII CU MEDIUL ÎNCONJURĂTOR

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Abstract. *The potato pests and diseases form an important set of species, which produce great damages. The main pest of potato crops is Colorado beetle (Leptinotarsa decemlineata). In order to efficiently control this pest there is not a safe technology with spectacular results. The extent of biological crop system by partial or complete renouncing at chemically pest control ensuring has imposed to find new alternative fighting methods, which should be non-pollutant methods. The efforts made to reduce the traditional chemical pesticides due to their negative impact upon the environment have led to the elaboration of ecological managing systems for L. decemlineata populations, mainly based on the utilization of physical methods and plant biological protecting means. The paper presents the results of certain researches related to possibilities to protect the potato crop by using the natural enemies of Colorado beetle (entomopathogens, predators) and at the same time an equipment for ecological control.*

Key words: Colorado beetle, *Beauveria bassiana*, ecological control.

Rezumat. *Dăunătorii şi bolile cartofului formează un complex bogat de specii care produc pagube importante. Principalul dăunător al culturilor de cartof este gândacul din Colorado (Leptinotarsa decemlineata). Pentru controlul eficient al acestui dăunător nu există o tehnologie sigură cu rezultate spectaculoase. Extinderea sistemelor de culturi biologice, cu renunţarea parţiala sau integrală la combaterea chimică, a impus gasirea de metode alternative de combatere, nepoluante. Eforturile de a reduce pesticidele chimice convenţionale datorită impactului lor negativ asupra mediului înconjurator au condus la elaborarea unor sisteme ecologice de management al populatiilor de L. decemlineata, bazate, în principal, pe utilizarea metodelor fizice şi a mijloacelor biologice de protecţie a plantelor. In lucrare prezentăm rezultatele unor cercetari privind posibilităţile de protecţie a culturii de cartof prin utilizarea duşmanilor naturali ai gândacului din Colorado (entomopatogeni, prădători) şi a unui echipament de combatere ecologică.*

Cuvinte cheie: gandacul din Colorado, *Beauveria bassiana*, combatere ecologica.

INTRODUCTION

The methods of ecological protection are more and more promoted within the current context of environmental-friendly policy. Colorado beetle is one of the most convincing example of insect endowed with genetic and biochemical characteristics for rapidly developing resistance at chemical substances currently used for its control. The concern for human health has led to potato crops extension, as "organic" system**,** therefore the use of chemical insecticides is completely forbidden. The ecological protection is performed by using alternative methods (biological and physical).

We present the results of some researches regarding the ecological protection of potatoes culture by using a control equipment and biological insecticides based om entomopathogenic microorganisms.

MATERIAL AND METHOD

1. The physical fight against Colorado beetle of potato crops has been tested by means of a specialized equipment. For conceiving and manufacturing this equipment we have taken into consideration the insect physical and behaviour characteristics which have to be controlled, the resistance at air currents of plants to be protected, the air currents orientation, the air rate flow and speed.

Within the speciality literature (Misener G. C., Boiteau G., 1993) it is mentioned that Colorado beetles better grip on interior side of leaves or on their edges. An adult Colorado beetle can maintain its adherence on the plant, in spite of the application of forces equivalent to up to 20 times its weight. So, its ultimate speed is of approx. 12,5 m s^{-1} (Khelifi M., Laguë C., Lacasse B., 2001). The larva's reach terminal velocities of : 9,4 m s^{-1} for L_4; 7,3 m s^{-1} for L_3 ; 5,9 m s^{-1} for L_2, where L_2,, L_3, L_4 represents the developing stages of Colorado beetle larva's. The adults and larvas of ultimate stages can be more easily detached out of the plant than those in incipient stages. The potato plants containing less than 12 leaves and a medium height under 40 cm could be exposed to air speed up to 27,5 m s^{-1} (at leafage level), without suffering a visible damage. (Khelifi M., 1996)

The ecological control equipment against Colorado beetle ECG-0 is aimed at pneumatically fighting against Colorado beetle in potato crops, by gathering the grubs and grown-up insects. The usage domain: include all the potato species in Romania, on different vegetation stages.

The frontal supporting frame is set on the tractor's chassis, in shape of deformable parallelogram, which is driven by a single effect hydraulic cylinder and ensures the equipment mobility in vertical plane. The frame of each section is designed at setting and supporting the active parts of the machine. Each frame is endowed with separated adjustments devices for every lateral sections. These settings are performed in relation with the distance between the rows of plants and their width. The gathering sections comprise the same constructive elements, with an appropriate arrangement of direction and acting sense on plants rows. The main elements of such a section are: the centrifugal fan, the pressure tubing and the pests collecting system. The air pressure tubing are manufactured as two rigid segments between which is found intercalary a linkage flexible element, allowing to adjust of the air pressing nozzle in comparison with the plants row. Each sections collecting part is placed in front of pressing nozzle of next section. The three centrifugal fans are individually driven by means of hydraulic engines. The oil comes from an own

hydraulic group, mounted by means of a rear supporting frame on the tractor's hydraulic elevator and driven from its PTO's.

The operating sytem of this equipment is based on the effect of grubs detachment out of Colorado beetle, on the potato plants by means of an air current produced by a centrifugal blower.

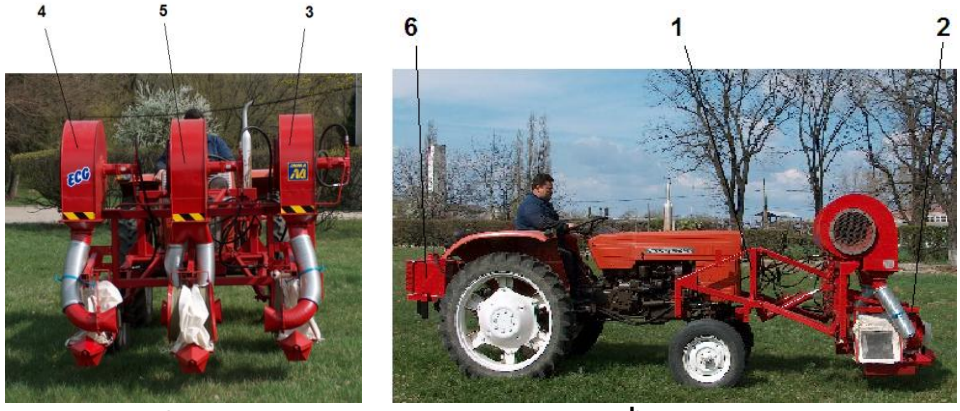

Fig. 1. Ecological control equipment against Colorado beetle ECG-0.
(a-frontal view si b –lateral view): 1- front supporting frame; 2- section frame; 3, 4 si 5-work sections; 6- hydraulic actuating installation.

The collecting sections enframe each plants row (left-right). The air jets. produced by the three centrifugal fans and evacuated through air nozzles "washes" the potato stems, causing the leaves shaking and the pests detachment (the beetles and their grubs) out of vegetal matter. At the same time the air currents also perform the pests transport towards the equipment special collecting division, from where they are subsequent taken out and destroyed. The air current speed is adjusted by modifying the fans flowing rate, as a result of their rotational speed frequency and this adjustment is performed in terms of plant vegetal and crop characteristics and crop infecting degree. The front supporting frame with mechanism of deformable parallelogram type ensure the adjusting of working height in comparison with the running surface and allows the optimum position of active parts as against the respective plants.

Main technical and functional characteristics of equipment ECG-0

- Equipment Type…….....carried
- Power source…….....L-445 tractor
- Operating system…….....hydraulic engine
- Number of rows processd at a single passing……...2
  - Distance between sections, m…….....max. 0.75
  - Type of fans…….....centrifugal
- Fans' rotating frequency, min^{-1}…….....2700
- Fans' flow, $m^3 h^{-1}$ …….....1886
- Working height, measured from the ridges' top min. mm……100
- Work speed, Km h^{-1}…….....2…4
- Air current speed:
  - at nozzle's output, m s^{-1}……25…46
  - at collector's input, m s^{-1} …….....10…13

2. It was tested the biological activity of an experimental fungal bioinsecticide formulated as concentrated conidian suspension ($2x10^8$ conidia/ml) whose active

ingredient was entomopathogenic fungus *Beauveria bassiana* (Bals.) Vuill. The experiment was organized in a potato crop in plots of 25 sq. m. The biological insecticide was applied in the post bloom potato culture infested with *L. decemlineata* larvae (L_1 – L_4). The fungal bioinsecicide was applied on leaf at a dose of 0.6 l / ha in 300-400 L solution / ha, resulting in a quantity of active ingredient per hectare of 1.2 x10^{11} conidia. There are made observations on the number of live larvae before the treatment and the number of dead larvae at 3, 5, 10 and 15 days after treatment. There were used CALYPSO 480 SC (0.08 l / ha) and Decis 2.5 EC (0.3 l / ha) as chemical standards. Biological efficacy of the product was calculated using the Haenderson-Tilton formula.

RESULTS AND DISCUSSIONS

By testing the equipment of Colorado beetle ecological control ECG-0 we have been able to verify its design and operating principle.Following the performed determinations we have found out that the air current speed coming out of nozzles at potato plants level was of max. 25 m s^{-1} – speed which does not hurt the plants (according to the previous statements). The air current speed has been appropiate for Colorado beetle grown-ups and grubs transport. The tests results synthesis is shown in table 1. In terms of a medium displacement speed v_m=2.4 Km h^{-1} and a coefficient of using the shift working time K_{07}=0.7, at a single passage, the effective output was of W_{ef}=0.336 ha/h, and the productivity of working shift time was of W_{shf}=1.88 ha/shf.

Tabel 1

Working qualitative de lucru

Den. no.	Working qualitative indices	Symbol	M.U	Value			
				Grubs L_1-L_2	Grubs L_3-L_4	Adults	Total
1.	Detachment grade	G_d	%	53,96	65,12	77,89	65,69
2.	Collecting grade	G_a	%	40,62	51,27	60,51	50,80
3.	Alive pests falling down (soil)	i_v	%	13,34	13,95	17,38	14,89
4.	Pests crushed by the tractor's wheels	i_s	%	5,63	8,16	3,67	5,82
5.	Control degree for Colorado beetle	G_c	%	46,25	59,43	64,18	56,62
6.	Plants' damaging stage by the equipment	G_v	%				3,36
7.	Plants' damaging stage by the tractor passage	G_{vt}	%				6,47

The analysis of results, taking into account the values obtained for the main qualitative indice, control degree for Colorado beetle, G_c=56.62% comprising the collecting degree and the percentage of insects crushed by tractor's wheel during the working process, is promising, although these performances do not reach the level of other foreign machines. The pests remained in the crops after a passage are numerous enough (approx 40% grubs and approx. 20% grown-ups) so that for efficiently destroy them several passages are necessary.

The results of the test performed in different experimental plots (P-1, P-2) are presented in tables 2 and 3. In both experimental plots the fungal bioinsecticides induced larval mortality from the 3-rd day of treatment, first and second instar larvae showing more sensitivity to the entomopathogenic action, compared with 3th and 4th instar larvae. In the P-1 plot is found progressive increase in the larval mortality, begining with the 5th day after bioinsecticide application. After 10 days of treatment the efficacy of the biological insecticide was superior to chemical standard (DECIS 2.5 EC), ranging between 97-100% (table 2).

In the experimental variants in P-2 plot, the biological insecticide had good efficacy in *L. decemlineta* larvae control, the larval mortality ranging between 92,5-100% for 1st and 2th larval instar, respectively 80.5 to 92.5% for 3th and 4th larval instar. Compared with chemical standard the experimental bioinsecticide recorded during the 15 days of observation, a lower biological effectiveness (table 3).

Table 2

Beauveria bassiana biological activity in _Leptinotarsa decemlineata_ control (experimental plot P-1)

Variant	Dose	Number of live larvae before of the treatment		(%)larvar mortality, after treatment							
				3 days		5 days		10 days		15 days	
		L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}
Fungal bioinsecticid	1,2x10^{11} conidia/ha	443	335	97,7	74,0	98,2	80,3	100	96,4	100	96,7
DECIS2,5EC	0,3 l/ha	489	411	94,7	87,8	95,3	92,2	90,3	89,3	87,3	85,2
Fungal bioinsecticid	-	473	382	470	394	400	400	381	376	399	387

Table 3

Beauveria bassiana biological activity in _Leptinotarsa decemlineata_ control (experimental plot P-2)

Variant	Dose	Number of live larvae before of the treatment		(%)larvar mortality, after treatment							
				3 days		5 days		10 days		15 days	
		L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}	L_{1-2}	L_{3-4}
Fungal bioinsecticid	1,2x10^{11} conidii/ha	151	138	92,5	80,5	95,0	82,5	100	92,5	100	90,0
CALYPSO 480 SC	0,3 l/ha	609	503	100	97,2	100	99,4	100	99,4	100	99,4
Fungal bioinsecticid		408	452	400	470	391	485	345	490	320	499

The diagnosis of the mycosis induced by the biological treatment was done by the "wet room" method; for estimating the biological effectiveness it was taken into account only the larvae that had specific signs of *B. bassiana* mycosis (fig. 2).

Fig.2. Micosed *Leptinotarsa decemlineata* larva (L_2 –L_4) from experimental plots with *Beauveria bassiana* treatments

As shown in fig. 2, the *B. bassiana* saprophytic development, proves a considerable advantage in terms of biological control as the fungal sporulation on insects bodies ensures the pathogen horizontal transmission from an infected host to another, without the need for a new phytosanitary intervention.

CONCLUSIONS

The results obtained during the tests of the ecological control equipment for Colorado beetle in potato crop, in real working conditions and as a result of a rich expertise represent important arguments for manufacturing of performant and harmonized with the environment equipment.

The test of biological insecticide based on *B. bassiana* has proved a very good efficacity in *L. decemlineta* control, which demonstrates its possible use in orgnic protection progrmas of potato crops.

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