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Efficient pest control of Pollen beetle (*Meligethes aeneus F.*) and possibilities for protecting the pollinators in oilseed rape agrocenosis

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Abstract- Pollen beetle (*Meligethes aeneus* F.) is a damaging pest of oilseed rape. Its harmful activity directly threatens the production and in some years it could compromise the yield. In many cases, the products applied in pest control, turn to be less efficient due to the conditions under which they are applied and the restricted application regime. In order to avoid the development of resistance, it is necessary to use insecticides having different mechanisms of action, which continue for a long enough period of time, with the aim of limiting the application of chemical substances and protecting natural pollinators and bees.
There is a combination of chemicals for a good control of Pollen beetle (*M.aeneus*). Knowing the mechanism of their action and their proper combination enables the increase of their efficiency.
For achieving that, the insecticide activity of the chemical compounds indoxacarb, deltamethrin + thiacloprid and thiacloprid in the commercial products Avaunt 150 EC, Proteus 110 OD and Calypso 480 SC, applied separately and in a combination with the adjuvant Codacide (95% rape oil + 5% plant emulsifier), was studied.

The results obtained showed that the product Avaunt 150 EC combined with the adjuvant Codacide, applied at the rate of 200 ml/da, provided an adequate protection against pollen beetle at the buttoning and flowering stages of oilseed rape, allowing the preservation of natural pollinators and providing an efficient pest control.

Index Terms- pollen beetle, chemical control, pollinators.

I. Introduction

The pollen beetle – *Meligethes aeneus* F. belongs to the category of the potentially significant pests on oilseed rape, whose harmful activity directly threatens the yield and compromises the quality of the production.
In many European countries – Denmark, Sweden, Switzerland and others, the pollen beetle is considered to be one of the key pests causing losses that may reach to 60-100% [1-13]. The damages are caused by both the adult insects and the larvae as well [14]. They feed on the flower buds, which significantly reduces the yield of seeds [15].

According to Coll et al. [2] the fight against the pollen beetle can be successful if conducted during the buttoning stage with density of 0,5-1 beetles per plant. Owing to the extended flowering stage of the oilseed rape and the migration of the pollen beetle, it is often necessary to apply two treatments: the first one during the buttoning stage and the second one in the beginning of the flowering stage [16].

Synthetic pyrethroids and neonicotinoids are usually used in the fight against the pollen beetle [17]. According to some authors Derron et al., [18]; Hansen, [19-20]; Wegorek, [17]; Muller et al., [21]; Glattkowski et al., [22], this pest has rapidly developed resistance to most of the active substances.

In his studies, Hansen [19] examines the resistance of the pollen beetle to synthetic pyrethroids: tau-fluvalinate, lambda-cyhalothrin, esfenvalerate and dimethoate. The conducted surveys show that the beetles survive up to 99% of the standard doses of the synthetic pyrethroids and up to 36% of dimethoate.
Neonicotinoids are among the most widely used insecticides in the world but the European Food Safety Agency restricted the use of some compounds of this class owing to the potential risk for the pollinators and the empty hive syndrome „Colony Collapse Disorder".

The studies conducted in Europe in the 90s prove that the neonicotinoid remains can accumulate in the pollen and the nectar of the treated plants and pose a potential risk to the pollinators [23].

Tennekes [24] has established that the neonicotinoids pass through the entire plant and reach the nectar and the pollen but also accumulate in the soil and the underground water. They have a negative effect not only on the insects that feed on the plant but also on those that pollinate it.

According to Bommarco et al., [25], the bees play an important role in the pollination of the oilseed rape, as a result of which we obtain higher yield compared to when the pollination has been done by the wind.

The limited number of insecticides and the developed resistance of the pollen beetle are the reasons that necessitate looking for new ways of fighting the pest that act differently, preserve the ecological balance in the environment and also the pollinators. Avaunt 150 EC is a suitable preparation which has a different course of action – it is the only insecticide from the new chemical group of oxadiazines. Avaunt 150 EC is an insecticide with stomach and contact action intended to control a large number of pests. This preparation blocks the sodium ducts in the nervous system of the insecticides by connecting with them directly and suppresses the flow of sodium ions. As a result, they stop eating, become disorientated with uncoordinated

movements, paralyze and die within 24-60 hours after applying the treatment. Unlike the other insecticides, there is no “knock-down” effect but they stop eating and do not cause damages.
Avaunt 150 EC is applied during the green button stage till the yellow button stage to control the adult insects of the pollen beetle when there are 1-2 beetles on the buttons.

For the purpose of extending the duration of the action of the applied insecticides, over the last few years the adjuvants have become very popular especially with the Brassicaceae family, whose leaves are covered with wax coating. They help improve the retention and the sticking of the working solution to the leaf surface. For that reason, the adjuvant Codacide is used, which contains 95% of oilseed rape + 5% of plant-based emulsifiers. The structure of the product is similar to that of the wax coating in plants, it is harmless and does not pollute the environment.
Considering the aforementioned, the purpose of this study is to test the duration and the efficiency of the insecticide Avaunt 150 EC with the adjuvant Codacide against the economically most significant pest on oilseed rape – the pollen beetle.

II. MATERIALS AND METHODS

The studies were conducted in the Experimental field of the Agricultural University – Plovdiv in an area sown with oilseed rape of the hybrid type Xenon as the size of the experimental lots was 25 m^2. The preparation Avaunt 150 (Indoxacarb) with a structural formula presented in Fig. 1 and adjuvant Codacide were used.

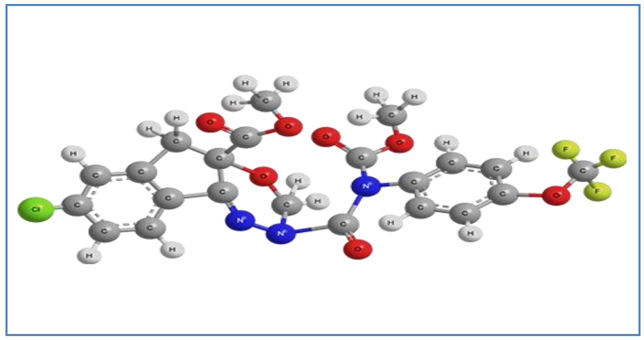

Figure 1: Structural Formula of Indoxacarb ($C_{22}H_{17}ClF_3N_3O_7$)
Indoxacarb: (S)-methyl 7-chloro-2, 5-dihydro-2-[(methoxycarbonyl) [4-(trifluoromethoxy) phenyl] amino] carbonyl] indeno [1,2-e] [1,3,4] oxadiazine-4a (3H) carboxylate

The treatments were applied during the buttoning stage. The experiment was based on the block method, three repetitions in eight variants.
Variant I – Avaunt - 17 ml/da;
Variant II – Avaunt - 17 ml/da + Codacide – 50 ml/da;
Variant III – Avaunt - 17 ml/da + Codacide – 100 ml/da;
Variant IV – Avaunt -17 ml/da + Codacide – 150 ml/da;
Variant V – Avaunt - 17 ml/da + Codacide – 200 ml/da;
Variant VI –Proteus - 45 ml/da + Codacide – 45 ml/da;
Variant VII – Calypso - 10 ml/da;
Variant VIII – control sample.

In each variant we marked 10 plants and the recording was done on the 3^{rd}, 5^{th}, 7^{th}, 10^{th}, 12^{th} and 15^{th} days.
We used as a reference the preparations Proteus 110 OD and Calypso SC from the group of the neonicotinoids. This enabled us to compare the efficiency and the duration of the activity of Avaunt with the adjuvant Codacide against the adult pollen beetles.

III. RESULTS AND DISCUSSION

As a result of the conducted spraying during the buttoning stage – the appearance of a yellow button, we registered good efficiency of the preparation Avaunt 150 EC compared to the products Proteus 110 OD and Calypso 480 SC. During the first counting, the number of the living pollen beetles in the variant treated with Avaunt was the largest 5,10 compared to the variants treated with Proteus + Codacide and Calypso (Table 1). The fast initial effect of the neonicotinoids can explain the obtained results. During the next counting, the number of the living pollen beetles in

Table I.Comparative analysis of the duration of the action of various insecticides on adult pollen beetles

Insecticides	Registered living adult pollen beetles						
	Before the treatment	3rd day	5th day	7th day	10th day	12th day	15th day
Avaunt	15,66	5,10*	3,06*	2,66*	1,33*	2,20*	0,43*
Proteus + Codacide – 45ml/da	12,93	2,20*	2,96*	4,56n.s	2,86*	1,90*	0,76n.s
Calypso	14,76	3,66*	4,30n.s	6,83*	4,16*	2,93n.s	0,90n.s
Control sample	11,70	6,73	5,00	5,00	1,76	3,53	1.00

LSD method with a risk of mistake α - 0,05%

Table II. Comparative analysis of the duration of the action of the insecticide Avaunt in combination with the adjuvant Codacide

Variants	Registered living adult pollen beetles						
	Before the treatment	3rd day	5th day	7th day	10th day	12th day	15th day
I. Avaunt – 17ml/da	15,66	5,10*	3,06*	2,66*	1,33n.s	2,20*	0,43*
II.Avaunt + Codacide – 50ml/da	16,60	3,16*	1,36*	1,96*	1,33n.s	1,73*	0,33*
III.Avaunt + Codacide – 100ml/da	12,70	3,70*	0,86*	2,50*	0,56*	1,53*	0,26*
IV.Avaunt + Codacide – 150ml/da	9,40	2,56*	0,93*	2,66*	1,13n.s	0,93*	0,60*
V.Avaunt + Codacide – 200ml/da	10,83	2,36*	0,53*	2,76*	0,36*	0,46*	0,10*
VI. Control sample	11,70	6,73	5,00	5,00	1,76	3,53	1.00

LSD method with a risk of mistake α - 0,05%

The variant treated with Avaunt gradually decreased and on the 15th day it reached 0,43 insects. Probably, as a result of the unilateral blocking of the Na^+ exchange in the ducts (in this case the chemical compound indoxacarb), unlike the synthetic pyrethroids which block the Na^+ and K^+ exchange, there is a slight initial effect. Eating is suppressed as well as the overall life activity of the treated beetles. As the disrupted exchange accumulates in the nervous system of the insects, the efficiency increases and reaches its highest values at the end of the period of testing (the 15th day).

After the applied combination with the adjuvant Codacide in a dose of 200 ml/da (Table 2), there is a good insecticide synergy which is manifested in the increased initial effect and the higher mortality rate among the insects. This combination compared with the reference Calypso and Proteus has higher indicators of the mortality rate throughout the entire period of registering.

The obtained results show that the product Avaunt 150 EC in combination with the adjuvant Codacide in a dose of 200 ml/da ensures good protection of the oilseed rape from the pollen beetle during the buttoning-flowering stage, which protects the natural pollinators and makes the fight against the pest successful.

IV. CONCLUSIONS

As a result of the conducted studies we can draw the following conclusions:

- in order to fight the pollen beetle – *Meligethes aeneus,* the preparation Avaunt 150 EC (indoxicarb) in a dose of 17 ml/da can be applied once at the end of the buttoning stage.

- the use of plant oils, such as Codacie in a dose of 200 ml/da increases the initial effect of the insecticide Avaunt and its efficiency for a period of 15 days.

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