

**EFFECT OF SYNTHETIC PYRETHROID LAMBDA-CYHALOTHRIN ON POPULATION
DYNAMICS OF CEREAL APHIDS AND APHID PREDATORS (COLEOPTERA:
COCCINELLIDAE) IN WINTER WHEAT**

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Abstract

The application of broad spectrum insecticides in reduced doses ensures an environmentally friendly crop protection and in addition to the elimination of aphids also a conservation of beneficial insects. The field investigations were carried out with winter wheat cultivar "Rusalka" in the vicinity of the city of Sofia., Bulgaria. The aphids and beneficial arthropods in winter wheat crops were evaluated by means of visual analysis (random plants). The insecticide application was carried out in the following variants: K0-untreated; K50- 50 ml/ha K75- 75 ml/ha. In the insecticide-treated variants in the days after the treatment, high mortality rates of 89-99 % of the cereal aphids were verified. The development of the coccinellids was strongly influenced by the insecticide application. The synthetic pyrethroid Karate Zeon caused even in the reduced application rate (K50) a nearly 100% decrease of the larval density. The density of the imagines increased again 14 days after the treatment.

Key words: winter wheat, cereal aphids, Coccinellidae, pyrethroid Karate Zeon

1. INTRODUCTION

The cereal aphids are among the most important pests in agriculture. They can cause considerable damage to cereal crops by their direct suction activity, honeydew and by their role as a vector of Barley Yellow dwarf virus, BYDV (Vickerman & Wratten 1979; Plumb 1995; Fabre 2003; Malschi et al. 2006).

The species *Sitobion avenae* (Fabricius 1775), *Rhopalosiphum padi* (Linnaeus 1758) and *Schizaphis graminum* (Rondani 1852) occur in cereal crops of Bulgaria on a regular basis. The direct damages caused by feeding of aphids and by their mass reproduction were observed more frequently in recent years (Maneva 2010).

The purpose of the Integrated Pest Management (IPM) is guaranteed by a selective use of plant protection products, the elimination of aphids as well as the protection of predators, so that their regulatory potential could be further used. The use of non-selective pesticides should also allow the protection of beneficial insects, as the examples used here pyrethroid Karate Zeon in reduced doses, when the differentiation in dose-response relationship between target and non-target organisms occurring in the lower application range.

In this study, opportunities should be sought for the efficient control of aphids in winter wheat and the protection of coccinellid predators.

2. MATERIALS AND METHODS

The investigations have been carried out with the winter wheat variety "Rusalka" in the vicinity of the city of Sofia, Bulgaria. The field experiments were established in 2011, on 1000 m² as a randomized

block design with four replications. The insecticide Karate Zeon is a micro-encapsulated formulation with the active ingredient lambda-cyhalothrin (100 g a.i./l) from the group of synthetic pyrethroids, which was chosen as an experimental plant protection product. The insecticide Karate is often used against cereal leaf beetles (*Oulema* spp.) and shield bugs (*Eurygaster* spp.). The investigations were carried out in the following variants: K0-untreated; K50 -50 ml/ha K75 -75 ml/ha. The insecticide was applied to the experimental area with a "low pressure" spray nozzle. The aphids and beneficial arthropods in winter wheat crop were evaluated by means of visual analysis (random plants). The plants (100/variant) were visually observed: per parcel 5 plants at 5 randomly selected points.

Alatae and apterae of aphids (*S. avenae*, *R. padi* and *S. graminum*) were sampled separately und counted. The coccinellids were separated in the stages of development. The animal material was determined to species level and counted.

3. RESULTS AND DISCUSSION

The results were based on the primary population of cereal aphids and coccinellids.

In the experimental 2011 the aphids *S. avenae*, *R. padi* and *S. graminum* were found during visual observation of randomly selected plants in a very different population density. *S. avenae* was clearly the dominant species. The population development of *R. padi* and *S. graminum* proceeded at very low level of density than of *S. avenae* and the individuals of the three species were summed.

The effect of the insecticide Karate Zeon was quantized on the basis of effectiveness for all three species. In addition, a statistical comparison of the population densities before and after the treatment was carried out (Table.1 and 2).

The statistical analysis of the population density of coccinellids in the experimental variants was performed in which the data of each observation date before and after treatment were summarized.

3.1 Cereal aphids

The first individuals of the cereal aphids could be found on 13 May in the yellow dishes. The colonization occurred very slowly during the relatively cool month of May (17 °C mean daytime temperatures and 77 % relative humidity), so that the first colonies of aphids were observed on the leaves on the 20.05 and on the ears on the 26 May. The wheat plants were in growth stages BBCH (47-59). The population developed an abundance maximum of 176 aphids per wheat plant by 10 June in the untreated-variant (Fig. 1). At this point, nearly 80% of the plants were attacked by aphids. The aphid population was down for a period of 10 days; no aphids were found on the 21 June.

The insecticide treatment was carried out on the 27 May at an average density of 40 aphids per plant and a relative percentage of attacked plants by 30-40%.

As Figure 1 shows, the karate-variants had a good initial effect. The population in the K50 variant has been clearly decimated; a renewed increase in the population began as from 2 June. In contrast, such an increase could not be observed in the K75 variant; the abundance remained very low (under 2 aphids/plant) during the entire investigation period.

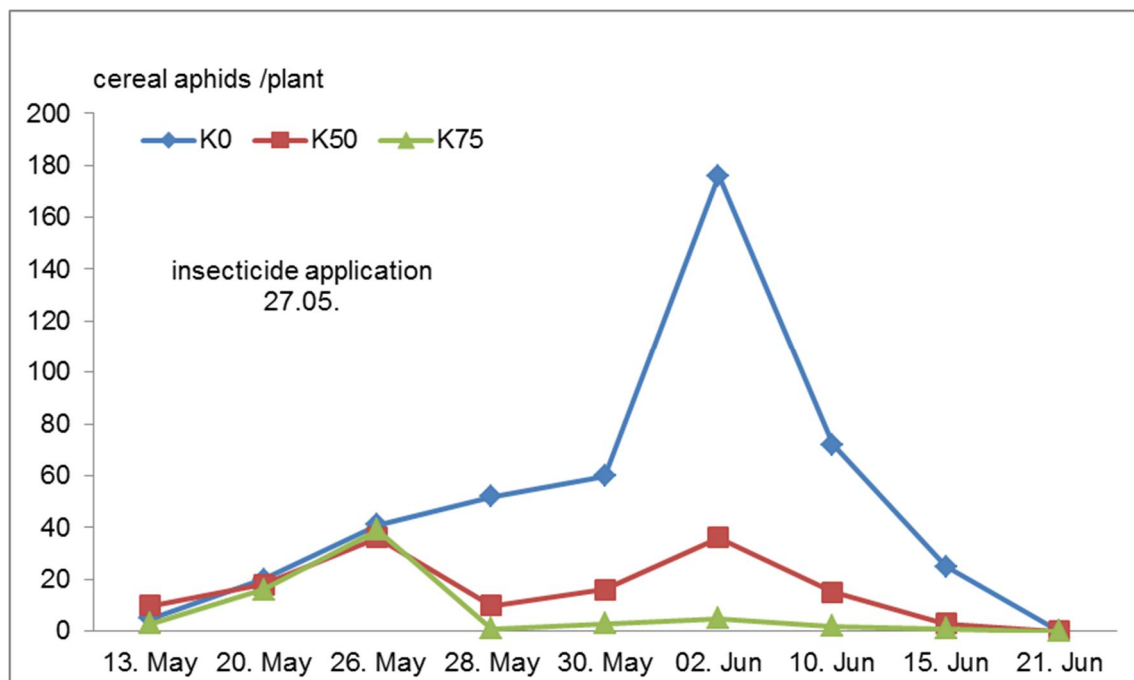


Figure 1. Population dynamics of cereal aphids (*S. avenae*, *R. padi*, *S. graminum*) in the insecticide-treated and untreated variants

The effectiveness of the treatments was evaluated as percentage of aphid mortality (Henderson & Tilton 1955; Floris et al. 2001). The corrected mortalities were 88-99% (Table 1). The reduced insecticide variant (K50) was characterized by the lowest efficiency, so that the population reached on 2 June 20% of the population density of the untreated variant. However, the application rate 75 ml/ha (commonly used in practice) showed higher effectiveness of the insecticide.

Table 1. Effectiveness (%) of differentiated application rates of the insecticide Karate Zeon against the cereal aphids

Insecticide-treated variants		
Application rate ml/ha		
Evaluation date	50 ml/ha	75 ml/ha
28. May	97	99
30. May	95	99
02. June	88	93
10. June	92	95
15. June	94	99

Application date 27 May 20011

The statistical analysis has confirmed the results depicted here. Statistically significant differences were found between the treated variants and the untreated variant at any time after the application. The K50 variant was significantly different from the K75 variant on the 3th day and 6th day after the treatment; as from the 14th day after the application, the differences were not proved to be significantly different (Table 2).

Table 2 Statistical comparison of the population densities of cereal aphids between the insecticide-variants and untreated variant; Duncan's test, $p < 0.05$

Variants	Days before or after treatment							
	-14	-7	-1	1	3	6	14	19
K0	a	a	a	a	a	a	a	a
K50	a	a	a	b	b	b	b	b
K75	a	a	a	b	c	c	b	b

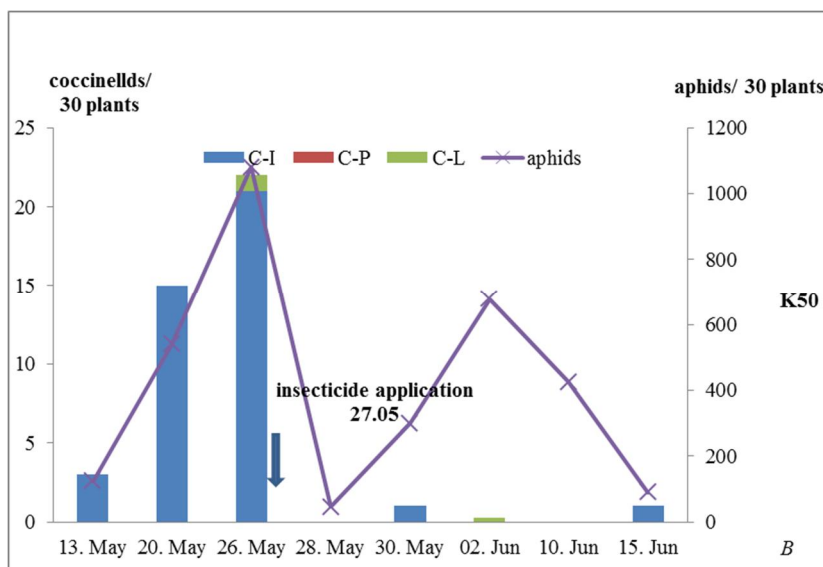
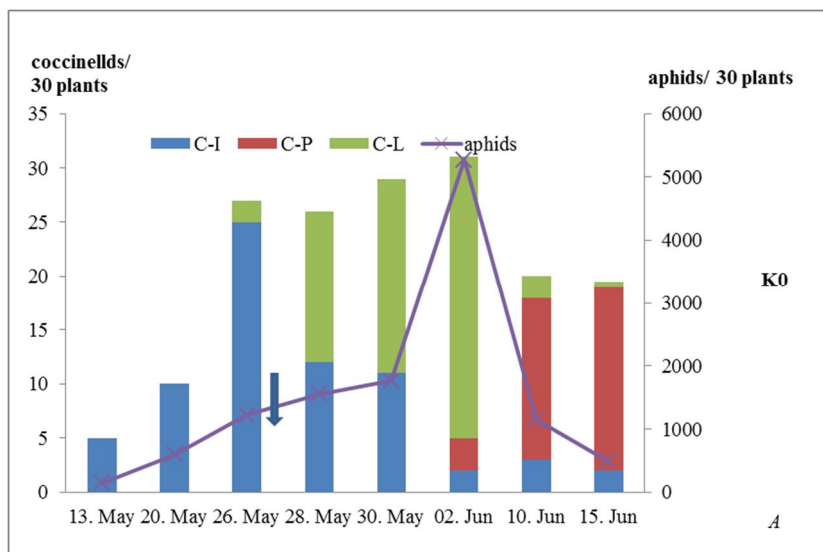
Application date 27 May 20011. Different letters indicate significant differences between the variants.

3.2 Coccinellids

In 2011, the coccinellids were the main natural enemies of the aphids in winter wheat crops. The species were dominated by the seven-spot ladybird *Coccinella septempunctata* Linnaeus 1758, the species *Harmonia axyridis* (Pallas 1773) was in a low population density, and *Adalia bipunctata* (Linnaeus 1758) was sporadic. The following graphs show the population dynamics of aphidophagous coccinellids (larvae, pupae, imagines) together with the course of attack of the aphids in the different experimental variants (Fig. 2). The population density was expressed as Individuals/30 plants.

The first Imagines on the wheat plants were counted at the beginning of visual analysis (13 May), and the first oviposition occurred on the 20 May. In the untreated variant, the abundance of coccinellid larvae also increased with increasing of the density of aphids (Fig. 2). The abundance peak of the larvae coincided with the abundance maximum of the aphids. The pupal density was at the highest, as expected, a week later.

The development of the coccinellids was strongly influenced by the insecticide application. The synthetic pyrethroid Karate Zeon caused in the K75 variant a 100% decrease of the larval density. Only 0.25 larvae/30 plants were recorded after the application of the reduced variant (K50). The density of the adults increased again 14 days after treatment in the K50 variant, probably due to immigration of coccinellids from untreated crops, slightly (Fig. 2)



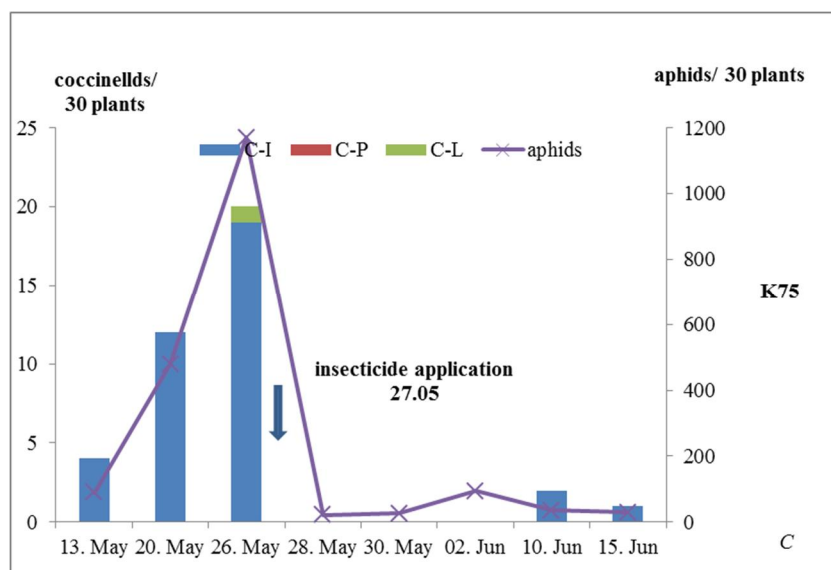


Figure 2. Population dynamics of cereal aphids (*S. avenae*, *R. padi*, *S. graminum*) and coccinellids in the insecticide- treated and untreated variants /A, B, C/

The statistical analysis showed that there were no significant differences between the larval densities in the experimental variants before treatment (Fig. 3). The larval and pupal densities in the untreated variant and in the two insecticide variants differed significantly from each other after the insecticide application.

The insecticide Karate Zeon is suitable for the efficient control of cereal aphids. The effectiveness against aphids in winter wheat was between 88 and 97% in the random sample even in the reduced variants. Karate at a rate of 10 ppm was referred to as very effective against *Metopolophium dirhodum* and *Rhopalosiphum padi* (Sallam et al. 2009). This observation could be confirmed by us, with the insecticide Karate Zeon which had a lasting effect. Heimbach (1990) also found for the pyrethroid Karate a long-term effect on the cereal aphids. The application rate of Karate 50 ml was sufficient to significantly reduce the population of the cereal aphids and to reach an effectiveness of 90% 8 days after the insecticide application (Pfaff 1991). Poehling et al. (1985) demonstrated in winter wheat for the synthetic pyrethroid Fenvalerate a lagged initial effect on the cereal aphids in the first 2 days after the application; the effectiveness was nearly 100% after 3-4 days.

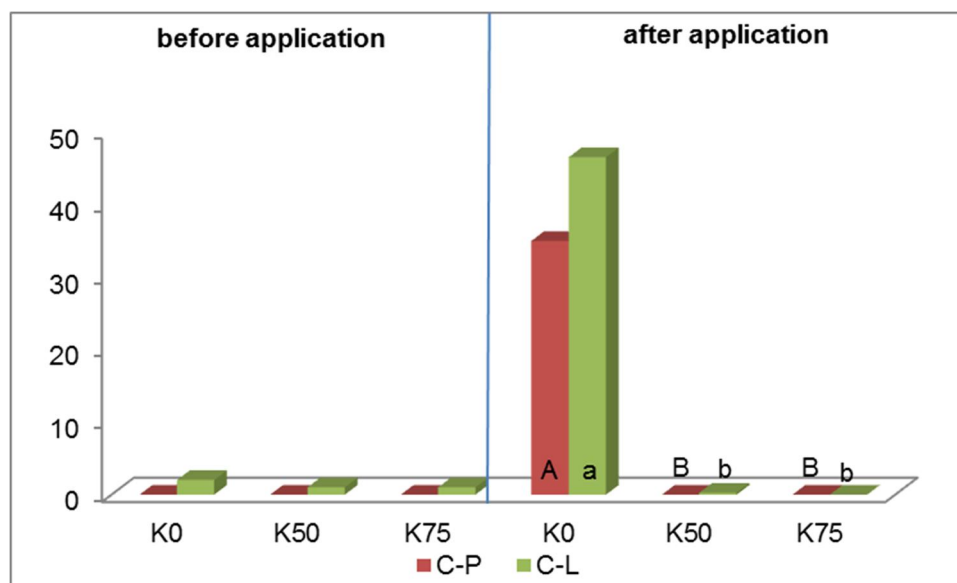


Figure 3. Amount of the coccinellid larvae and pupae before or after the insecticide treatment (Columns with different letters indicate significant difference at $P < 0.05$; H-Test nach Kruskal-Wallis, $p \leq 0.05$).

In the study period, the population density of coccinellids was synchronized with the aphid density. In this study, the Karate Zeon showed significant treatment effects on all coccinellid development stages, the effect of the reduced application rate differed little from the K75 variant. In semi-field and laboratory investigations (spray application), Bouwman (1994) established the high toxicity of Karate against coccinellids. Even application rate of 12.5 ml led to a 100% mortality. The high toxicity of lambda-cyhalothrin against non-target arthropods in winter wheat has been documented in the literature (Wick & Freier 2000). Heimbach (1990, 1991) found after treatment of winter wheat with different insecticides a high percent of dead coccinellids in the karate- variants. Brown et al. (1983, 1990) showed in field studies the immense toxicity of Karate for ladybird *C. septempunctata* and Jalali et al. (2009) found, that lambda-cyhalothrin, using in agricultural crops, was highly toxic to the two-spot ladybird *Adalia bipunctata*. These results are consistent with our own investigations.

4. CONCLUSIONS

The cereal aphids in the experimental years were present in relatively high density and could be controlled effectively with a reduced application rate of the insecticide Karate Zeon.

The insecticide in the reduced application rate has been toxic for all species of coccinellids. Therefore, this insecticide should be used in pest management with consideration of economic threshold of harmfulness of the cereal aphids

The reduced rate of application of the insecticide could give higher contribution margin in cereal crops.

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