BIOLOGICAL EFFICACY OF INSECTICIDES IN THE CONTROL OF JAPANESE GRAPE CICADA (*Arboridia kakogowana* Mats.) IN THE CONDITIONS OF THE SOUTH OF UKRAINE

Lyudmila Baranets[1], Galina Balan[2] ,Olga Perepelitsa[3], Alla Leshchenko[4]

[1]Candidate of Agricultural Sciences, Leading Researcher in Phytopathology and Plant Protection, National Scientific Centre «V.Ye. Tairov Institute of Viticulture and Winemaking» NAAS of Ukraine, ludmila.baranez77@gmail.com

[2]Candidate of Agricultural Sciences, Associate Professor of Plant Protection, Genetics, and Breeding, Odessa State Agrarian University, fitoizr@gmail.com

[3]Post-graduate Student, National Scientific Centre «V.Ye. Tairov Institute of Viticulture and Winemaking» NAAS of Ukraine, oliahomenko888@gmail.com

[4]Researcher, National Scientific Centre «V.Ye. Tairov Institute of Viticulture and Winemaking» NAAS of Ukraine, siren@meta.ua

Abstract

In recent years, due to the expansion of the range and the increase in the harmfulness of leafhoppers, the study of their species diversity and the development of protective measures to control their numbers have become actual in vineyards. In the conditions of the south of Ukraine, from a large species diversity of leafhoppers that are found in vineyards, in four years of research (2017–2020), we have established an increasing activity of development and spread of the Japanese grape leafhopper (*Arboridia (Erythroneura) kakogowana* Mats.), which is an invasive (alien) species for Ukraine. Due to the annual damage to grapes by this cicada, plants are depleted, immunity and product quality are reduced. It was found that the highest number and, as a consequence, the harmfulness of leafhoppers is observed in the second half of the growing season (July–September) during the period of active growth and ripening of grapes. The greatest development of leafhoppers was recorded in thickened vineyards with the presence of vegetative weeds.

The article presents the results of studying the effectiveness of insecticides against Japanese grape cicada in the South of Ukraine. Biological preparation Aktofit (0.2%) EC and other insecticides from different chemical groups were used: Voliam Flexi (480 g/l) SC, Dursban (480 g/l) EC, Karate Zeon (50 g/l) CS, Koragen (200 g/l) SC, Proclaim (5 g/kg) SG, Engeo (247 g/l) SC. This insecticides have shown varying efficacy. The highest efficiency was obtained with the insecticides Voliam Flexy (300 g/l) SC – 89.3% and Engeo (247 g/l) SC – 86.3%, which contain two active substances with a different mechanism of actions. Very low efficiency in controlling the number of leafhoppers was obtained with the biological preparation Aktofit (0.2%) EC –

53.8%. According to the research results, we can conclude, that the most effective and basic method controlling the Japanese grape leafhopper remains the chemical. The decision about need of treatments should be made only after assessing the real phytosanitary situation, taking into account the threshold of the number of pests, harmfulness, and the degree of colonization of plants. With a low number of phytophages, continuous treatments should be abandoned, limiting themselves to spraying outbreaks of mass reproduction.

Key words: Japanese grape leafhopper, insecticides, biological effectiveness.

Introduction

Recently, in the vineyards of Ukraine and other countries, both in industrial plantings and personal farms, an increase in the number of Japanese (Far Eastern) grape leafhoppers (*Arboridia kakogowana* Mats.) has been observed due to a number of reasons. First of all, these are climatic changes, characterized as a persistent thermal anomaly, the ability of the leafhopper for mass reproduction and its high ecological plasticity to changing environmental conditions [1, 3, 4, 5, 10].

The leafhopper develops in three generations from April to October, and under especially favorable conditions gives the fourth generation. Dry weather increases the probability of mass emergence of cicadas. Migration to wintering sites begins in mid-late September. Adult insects overwinter, which leave their wintering places at an air temperature of +10...+12 °C. First, they feed on weeds, which begin the growing season earlier, and then move on to grape plants. After additional feeding, the females lay their eggs in incisions made by the ovipositor in the veins of the underside of the leaf. The larvae go through five instars in their development. The developmental cycle of one generation is approximately 35–40 days [5, 6, 7].

Adults, nymphs, and leafhopper larvae live in colonies on the underside of grape leaves along the veins, sucking out the juice. As a result of their nutrition, chlorophyll is destroyed in damaged cells and white chlorite spots are formed on the upper side of the leaf blade, resulting in discoloration of the leaves [8]. Many researchers have found that the Japanese grape leafhopper mainly inhabits varieties with intense leaf pubescence (Cabernet Sauvignon, Aligote, Saperavi, Odessa Black and many others) [9].

The basis of the modern system of protection of vineyards is the development of scientifically based schemes for the use of the highly effective preparations that ensure reliable control of the development of harmful organisms. Taking this into account, the study of the effectiveness of a modern assortment of insecticides in order to determine the optimal timing of their use in the fight against Japanese vine leafhoppers is a topical issue and has practical significance.

Methodology

Aim. Determination the effectiveness of the insecticides used in the protection of vineyards from the Japanese vine leafhoppers and to establish the optimal timing and frequency of their use.

Materials and methods

The research was carried out on the variety Odessa black, 2008 year of planting. Planting scheme — 3 x 1.5 m. The formation of plants is a double-sided cordon with a stem height of 70–75 cm, which is severely damaged by leafhoppers. In the course of the research, the methods generally accepted in entomology and plant protection were used [11].

To identify the species of leafhoppers, the method of route surveys was used in the period from April to October. To catch insects, we used the method of collecting individuals in entomological vessels and the use of yellow glue traps, which make it possible to track winged forms. Signal traps were placed vertically in the area of the bush, inspection and replacement was carried out at intervals of once every 2 weeks.

Identification and counting of captured insects were made in the laboratory using an XY-B2 trinocular microscope and an SZM-45 T2 stereoscopic microscope. The species was identified based on the morphological characteristics of adults using generally accepted identifiers and with the involvement of an electronic resource.

To determine the effectiveness of preparations for controlling the number of Japanese grape cicada an experiment was laid, which included 9 variants. Six insecticides belonging to different chemical groups and one biological preparation were tested (Table 1). Each variant included 20 plants, which corresponded to 4 replicates of 5 plants each. The obligatory variants were: control — vines without treatments and the standard (standard) — insecticide, which is used by the farm. Placement of variants is randomized, replicates are systematic. Spraying was carried out using STIHL SR 420 when nymphs of younger age groups appeared, depending on the economic threshold of harmfulness (EPV), which, according to [6], is more than 15 individuals.

Table 1. – Scheme of production experiment to study the effectiveness of insecticides against Japanese grape cicada (*Arboridia kakogawana* Mats.) SE "DG Tairovske", variety Odessa black, 2017–2020.

Experience variant	Consumption rate of the insecticides, l, kg/ha	Development phase of vine	Date of treatment
1. Control	without protective treatments against cicadas		
2. Standard (Confidor (200 g/l) SL)	0.2	intensive growth of grapes	I- III decades of July
3. Aktofit (0.2%) EC	0.2		
4. Voliam Flexi (300 g/l) SC	0.3		
5. Dursban (480 g/l) EC	1.5		
6. Karate Zeon (50 g/l) CS	0.15		
7. Coragen (200 g/l) SC	0.2		
8. Proclaim (5 g/kg) SG	0.3		
9. Engeo (247 g/l) SC	0.18		

Observations of the change in the state of leafhopper populations after treatments were made using the method of counting the number by the moving stages of the pest with an interval of 3–5 days (3, 5, 10 15 days after treatment) with the obligatory consideration of the number of the pest before the treatment of plants. The average number of mobile stages of leafhoppers per leaf was determined according to the variants of the experiment.

The biological effectiveness of the insecticides used to reduce the number of leafhoppers relative to the initial, adjusted for control, was calculated by the Abbott's formula: $E = (x-y) / x \cdot 100\%$, where E – is the effectiveness of insecticides; x – is the number of leafhoppers in the control; y – the number of leafhoppers in the experimental version.

Results

Long-term monitoring of the flight dynamics of the imago of Japanese grape cicada with yellow glue traps, as well as accounting for the population of grape leaves by pest larvae showed that the highest number and, consequently, its harmfulness was observed in the second half of the growing season (I–III decades of July) second generation pest. In this regard, the treatment of plantations to study the effectiveness of the insecticides according to the experimental variants, was carried out from the first decade of July to the third decade of August during the development of larvae of the younger generations of the second generation.

Observations of the biology of the pest showed that the appearance of the imago of the first generation of Japanese grape cicada in the growing seasons of 2017–2020 was observed in the first decade of April. The number was small — 5–8 individuals per yellow glue trap and an average of 1.5–2.3 larvae per leaf. Egg lying was recorded for the period of the second decade of April. Therefore, the first generation of the pest does not cause significant damage to the plantings. Most of the mass spread of the pest in the region was observed in the I–II decades of July.

Processing according to the research options was made on the day of the preliminary accounting. Further analysis of the number of pests (after treatments) was performed on day 3, day 5, day 10 and day 15. The results of the calculations showed the high efficiency of the applied insecticides with a prolonged protection period. Thus, the insecticides Voliam Flexi (300 g/l) SC and Engeo (247 g/l) SC over the years of the study helped to reduce the average number of pests to 1.7-1.9 individuals of larvae per 100 cm^2 leaf surface, at control values of 24.6 individuals (Table 2).

Experience variant	The average number of larvae per 100 cm of leaf surface				
	before treatment	a few days after treatment			
		3 days	5 days	10 days	15 days
1. Control	18.9	20.9	25.7	22.5	24.6
2. Standard (Confidor (200 g/l) SL)	22.8	9.1	4.6	3.8	3.4
3. Aktofit (0,2%) EC	16.9	14.1	11.9	7.3	9.5
4. Voliam Flexi (300 g/l) SC	21.4	3.3	2.3	2.2	1.7
5. Dursban (480 g/l) EC	19.5	4.6	3.7	2.9	2.5
6. Karate Zeon (50 g/l) CS	18.5	5.5	4.1	3.3	2.3
7. Coragen (200 g/l) SC	22.9	3.8	2.9	2.4	2.0
8. Proclaim (5 g/kg) SG	18.4	4.3	3.5	2.5	2.1
9. Engeo (247 g/l) SC	17.2	3.5	2.6	2.3	1.9

Table 2. – Influence of treatments on the number of Japanese grape cicadas (*Arboridia kakogawana* Mats.) according to the variants of the experiment, SE "DG Tairovske", variety Odessa black, 2017–2020.

It should be noted the rate of action of these drugs in the fight against cicadas: taking into account on day 3, the number was 3.3 and 3.5 individuals, with 20.9 individuals in control. Accordingly, the biological efficiency in these variants was the highest and, depending on the date of accounting, ranged from 80.7% to 94.3%.

As a result of studies in all studied insecticides, the biological effectiveness in controlling the number of Japanese grape cicada was higher than the reference version, which used the insecticide Confidor SL, which had an average efficiency of 67.4% (Fig. 1).

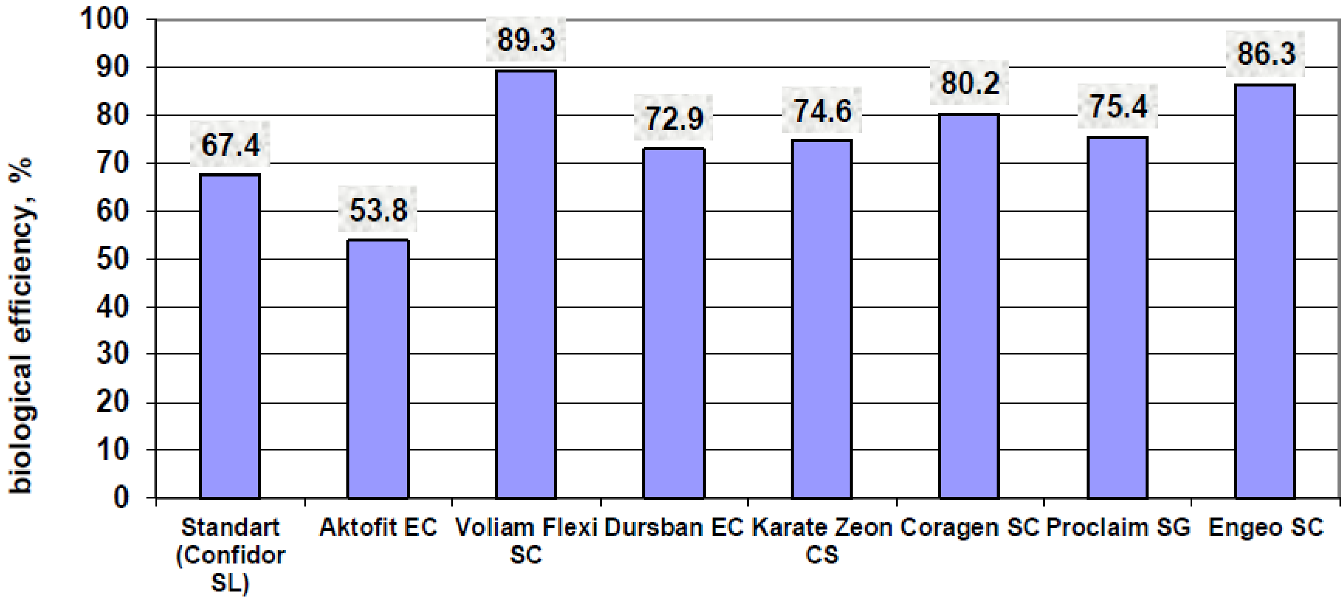

Fig. 1. The average biological effectiveness of the insecticides used against the Japanese grape leafhopper on the vineyards, DP "DG Tairovske", variety Odessa black, 2017–2020.

According to the studies, the best results were shown by two insecticides – Voliam Flexi SC – 89.3% and Engio SC – 86.3%. Slightly lower efficiency was observed for the insecticides Dursban EC – 72.9%, Karate Zeon CS – 74.6% and Proclaim SC – 75.4%. The lowest efficiency was obtained for the biological contact-intestinal insecticide Aktofit EC, which was 53.8% and was achieved with a low number of leafhoppers.

Conclusions

The greatest protective effect of controlling the number of Japanese grape leafhoppers is observed when using combined insecticides with active ingredients of different mechanisms of action — Voliam Flexi SC (thiamethoxam, 200 g/l + chloranthraniliprol, 100 g/l) with a consumption rate of 0,3 l/ha and Engeo SC (thiamethoxam, 141 g/l + lambda-cycalotrin, 106 g/l) with a consumption rate of 0.18 l/ha, which combines a powerful knockdown effect with a long period of crop protection.

The optimal period for making treatments is the period of development of the second and third generations of leafhoppers. If necessary, 2 treatments should made with an interval of 12–14 days, during the period of active growth and the beginning of ripening of grapes. The processing period is the period of mass hatching of larvae.

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