Comparative Effect of Different Insecticides and Processed Kaolin on *Cacopsylla pyri* L. Population Reduction

Komparativni učinak različitih insekticida i kaolina na smanjenu brojnost populacije *Cacopsylla pyri* L.

Tomaš, V., Mihaljević, I., Vuković, D., Viljevac Vuletić, M., Galić, V., Tomeš, V., Brus, K., Zdunić, Z.

Poljoprivreda / Agriculture

ISSN: 1848-8080 (Online)
ISSN: 1330-7142 (Print)

https://doi.org/10.18047/poljo.28.1.1

Fakultet agrobiotehničkih znanosti Osijek, Poljoprivredni institut Osijek

Faculty of Agrobiotechnical Sciences Osijek, Agricultural Institute Osijek

ISSN 1330-7142
UDK=632.951+679.861;595.7
https://doi.org/10.18047/poljo.28.1.1

COMPARATIVE EFFECT OF DIFFERENT INSECTICIDES AND PROCESSED KAOLIN ON *Cacopsylla pyri* L. POPULATION REDUCTION

Tomaš, V.(1), Mihaljević, I.(1), Vuković, D.(1), Viljevac Vuletić, M.(1), Galić, V.(1), Tomeš, V.(2), Brus, K.(3), Zdunić, Z.(1)

Original scientific paper
Izvorni znanstveni rad

SUMMARY

Cacopsylla pyri ***L. (Hemiptera: Psyllidae) is one of the most serious economic pear pests in Eastern Croatia. Previous methods of pear control in the Republic of Croatia have led to the development of an insect population resistan to certain active ingredients. The objectives of this two-year study were to determine the optimal number of treatments for psylla control based on the monitoring of pest life cycle and to determine the effectiveness of processed kaolin in controlling the pear psylla in comparison with other chemical insecticides in four different treatments (T1. IPM-integrated protection program – diflubenzuron, spirotetramat, abamectin, acetamprid; T2. acrinatrin + abamectin, T3. kaolin clay, T4. control treatment). The research was conducted in 2017 and 2018 in a six-year-old experimental pear orchard on three varieties (Williams, Conference, and Abate Fetel). Monitoring of the pest population and its development was performed by visual inspection on two one-year shoots per tree of each variety in all replicates. The T1 treatment demonstrated the highest efficiency, between 84-95%, depending on the year, while the kaolin treatment had the lowest one, but it varied greatly from one year to the other (37-71%).***

Keywords: efficiency, kaolin, pear psylla, plant protection, integrated pest management, pyrethroids

INTRODUCTION

Pear psylla (*Cacopsylla pyri* L.) is a monophagous pest of great economic importance. It causes several direct and indirect damages (Ciglar, 1989; Civolani, 2012). Direct damage occurs due to an intensive feeding by sucking phloem juices. It has a large number of nymphal stages and a large number of generations per year (four to five). The results therefore are a reduced fruit tree "vigor" and a yield decrease (Nin et al., 2012). Indirect damages occur due to a reduced intensity of photosynthesis caused by the present population of sooty molds (Almaši et al., 2004; Nin et al., 2012). Pear psylla is a vector of phytoplasma—the causative agent of pear decline (Carraro et al., 1998; Horton, 1999; Sule et al., 2007). The disease spreads very quickly throughout the plantation, resulting in large yield losses concerning the infected trees (Avineunt et al., 2009). In Croatia, the control of pear psylla requires an increased number of chemical treatments, that is, from five to ten, due to their reduced effectiveness caused by the pest's ability to develop insecticides resistance (Pree et al., 1990; Schaub et al., 2001). The control program of the pear psylla in Croatia does not include this pest's biological control, which should be preferred due to a lack of harmful effects on predators (Koucourek and Stara, 2006). Previous studies have proven that the

(1) Vesna Tomaš, Ph. D. (vesna.tomas@poljinos.hr), Ines Mihaljević, Ph. D., Dominik Vuković, Mag. Eng. Agr., Marija Viljevac Vuletić, Ph. D., Vlatko Galić, Ph. D., Prof. Dr. Zvonimir Zdunić, Agricultural Institute Osijek, Južno predgrađe 17, 31000 Osijek, Croatia, (2) Viktor Tomeš, Mag. Eng. Agr., Bioinspekt Ltd., Đakovština 2, 31000 Osijek, Croatia, (3) Krunoslav Brus, Mag. Eng. Agr., Croatian Agency for Agriculture and Food, Vinkovačka cesta 63 c, 31000 Osijek, Croatia

kaolin clay applied to the plant organs on fruit trees is very effective in controlling the range of pests, including *Cacopsylla* spp. (Glenn et al., 1999; Puterka et al., 2000; Unruh et al., 2000; Pasqualini et al., 2002; Pascual et al., 2010). The kaolin particle film does not kill the insects, but it acts as a repellent or barrier. The side effects on beneficial arthropods are low (Lapointe, 2000; Showler and Sétamou, 2004; Glenn and Puterka, 2005). Kaolin is not harmful to the non-target organisms, as well as to the environment. The studies conducted by the Environmental Protection Agency in America (EPA, 1999) indicated no adverse effects either on spiders, honeybees, or on aquatic organisms. Due to this action mode, kaolin fits well into an ecological as well as into an integrated pest control strategy (Higbee and Unruh, 1994). The aim of this study was to investigate the effectiveness of kaolin clay treatment in controlling the pear psylla and compare it with effectiveness of other chemical treatments, as well as to define an optimal number of control treatments according to the monitoring of pest developmental stages.

MATERIALS AND METHODS

Plant material and experimental design

The trial was conducted in an experimental pear orchard of the Agricultural Institute Osijek, eastern Croatia (45°31′44 04′N, 18°45′94′E) during 2017–2018. The varieties represented in the trial were *Viljamovka*/ rootstock BA 29 / intermediate rootstock *Pastorčica*; *Conference*/rootstock MA; and *Abate Fetel*/rootstock MA. A plant distance amounted to 3.2 x 0.8 m, and the trees were pruned as spindle bush, whereas 15 trees per each treatment and control were used in the experiment. Treatment 1 (T1) was a standard integrated pest control program using four different active ingredients, with a different mode of action. The application time of each insecticide was determined with regard to its specificity of action on a particular pest development stage. The following active ingredients were used in T1: diflubenzuron (*Dimilin* SC 48) at a dose of 250 ml ha^{-1}, spirotetramat (*Movento*) at a dose of 1500 ml ha^{-1}, abamectin (Vertimec 018 EC) at a dose of 1500 ml ha^{-1} and acetamiprid (*Mospilan* 20 SP) at a dose of 500 ml ha^{-1}. In Treatment 2 (T2), a preparation *Rufast Nova*, based on two active ingredients (acrinatrin + abamectin), was used in a dose of 1000 ml ha^{-1}, while a biological preparation based on kaolin clay (*Cutisan*) was used in Treatment 3 (T3) in a dose of 35000 g ha$^{-1.}$ Treatment 4 (T4) was a control treatment, and only water was applied. The time of the treatment was determined on the basis of results of critical thresholds, obtained by visual inspection with an entomological magnifying glass, as well as by a beating tray. The application dates were the same for all treatments. Prior to the treatment and subsequent to the treatment referenced, all developmental pest forms, that is, the eggs and nymphs (L1-L3, L4-L5), were defined by counting the same marked shoots (two shoots per every test tree, a total of fifteen trees per treatment) while using an entomological magnifier (10x). Visual monitoring of different developmental stages of pear psylla was conducted every six to ten days from the beginning of May to the beginning of August (12 in total). In late spring and summer, the critical thresholdamounted to 10% of infected shoots, determined by visual method (Baggiolini, 1965). For each treatment, efficiency was calculated based on a difference in the number of pest specimens prior to the treatment and subsequent to the treatment when compared to the control, using a formula according to Abbott (1925). In 2017, there were a total of seven applications per treatment (Table 1), while there was a total of six applications (Table 2) in 2018.

Table 1. Application dates in 2017 for all treatments in trial (T1, T2, T3, T4) and list of used insecticides in T1

Tablica 1. Datumi aplikacija u 2017. za sve tretmane u istraživanju (T1, T2, T3, T4) i prikaz insekticida u T1

Treatment date / *Datum aplikacije*	Product name / *Trgovački naziv*	Active ingredient / *Aktivna tvar*	Concentration / *Koncentracija*	Allowed number of applications / *Dopušteni broj aplikacija*	Waiting period till harvest / *Karenca*
4 May	*Dimilin* SC	diflubenzuron	0,025%	1	21
26 May	*Vertimec* 018 EC + mineral oil / *Vertimec* 018 EC + *mineralno ulje*	abamektin	0,15%+0,25%	2	14
11 June	*Movento*	spirotetramat	0,15%	2	21
26 June	*Vertimec* 018 EC + mineral oil / *Vertimec* 018 EC+ *mineralno ulje*	abamektin	0,15%+0,25%	2	14
5 July	*Actara* 25 WG+mineral oil / *Actara* 25 WG+*mineralno ulje*	thiamethoxam / *tiametoksam*	0,02%+0,5%	2	21
19 July	*Mospilan* 20 SG	acetamprid	0,05%	1	14
31 July	*Coragen* 20 SC	chlorantraniliprole / *klorantranilprol*	0,02%	2	14

Table 2. Application dates in 2018 for all treatments in trial (T1, T2, T3, T4) and a list of used insecticides in T1.
Tablica 2. Datumi aplikacija u 2018. za sve tretmane u istraživanju (T1, T2, T3, T4) i prikaz insekticida u T1.

Treatment date/ *Datum aplikacije*	Product name/ *Trgovački naziv*	Active ingredients/ *Aktivna tvar*	Concentration/ *Koncentracija*	Allowed number of application / *Dopušteni broj aplikacija*	Waiting period till harvest / *Karenca*
10 May	*Movento*	spirotetramat	0,15%	2	21
26 May	*Actara* 25 WG + mineral oil / *Actara* 25 WG + *min. ulje*	thiamethoxam / *tiametoksam*	0,02%+0,5%	2	21
8 June	*Dimilin* SC	diflubenzuron	0,025%	1	21
15 June	*Vertimec* 018 EC + mineral oil / *Vertimec* 018 EC + *min. ulje*	abamektin	0,15%+0,25%	2	14
22 June	*Mospilan* 20 SG	acetamprid	0,05%	1	14
5 July	*Coragen* 20 SC	chlorantraniliprole / *klorantranilprol*	0,02%	2	14

Climate data

During the two research years (2017 and 2018), meteorological data were collected from the meteorological station (CDA) set up at the Agricultural Institute Osijek (Figures 1 and 2). The amount of precipitation and the mean, minimum, and maximum air temperatures were monitored.

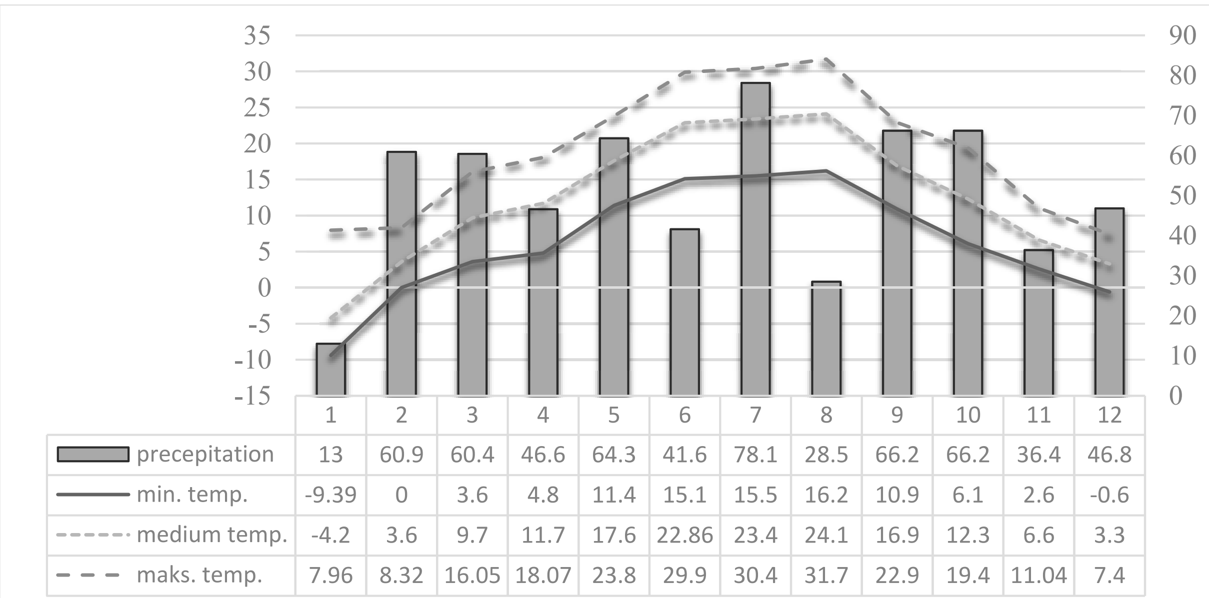
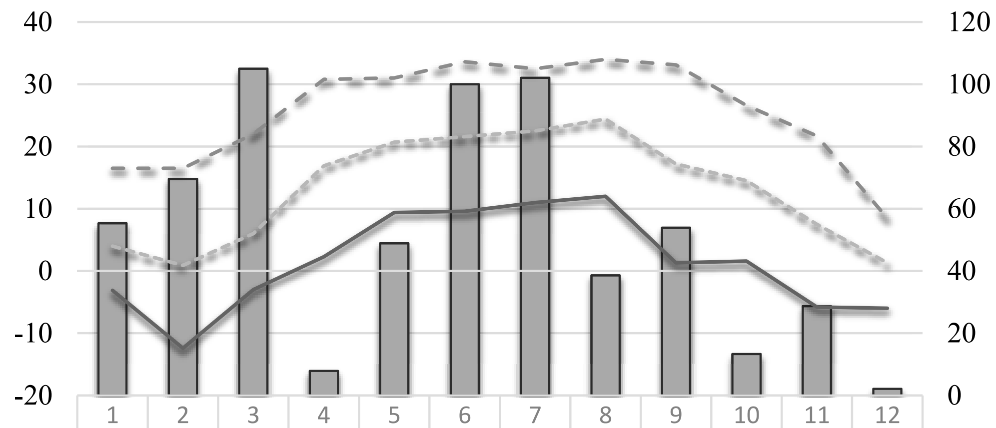


Figure 1. Climate diagram (precipitation in mm, min., medium, and max. temperatures in °C) for Osijek in 2017.
Grafikon 1. Klimatski dijagram (oborine u mm, min., srednja i maks. temperature u °C) za Osijek u 2017. godini.



	1	2	3	4	5	6	7	8	9	10	11	12
precepitation	55.3	69.6	105	7.9	48.9	100	102.1	38.6	53.9	13.3	28.7	2.1
min. temp.	-3.1	-12.4	-3	2.3	9.4	9.6	11	12	1.3	1.6	-5.8	-6
medium temp.	4	0.9	6	16.9	20.7	21.6	22.5	24.4	17.2	14.5	7.5	1.3
maks. temp.	16.5	16.5	22	30.8	31	33.6	32.5	34	33.1	26.6	21.7	8.5

Figure 2. Climate diagram (precipitation, min. temp., medium temp., max. temp.) for Osijek in 2018.

Grafikon 1. Klimatski dijagram (oborine, min. temp., srednja temp., maks. temp.) za Osijek u 2018.

Statistical analyses

The software package *R* (R core team, 2019) was used in the statistical analysis. A multifactorial analysis of variance was performed. The differences between the treatments and their impact on the number of pest developmental stages were determined by an LSD test.

RESULTS AND DISCUSSION

The results demonstrated that all treatments had a significantly lower number of oviposited pear psylla eggs when compared to the control in both years (Figure 3 left and right). Glenn et al. (1999, 2002) concluded that the adult treated with kaolin clay became heavily coated with kaolin particles, having constantly tried to remove these particles from their body, which disabled them to feed or to oviposit. This is in accordance with our results concerning a lower number of eggs in the kaolin treatment (T3) when compared to the control (T4).

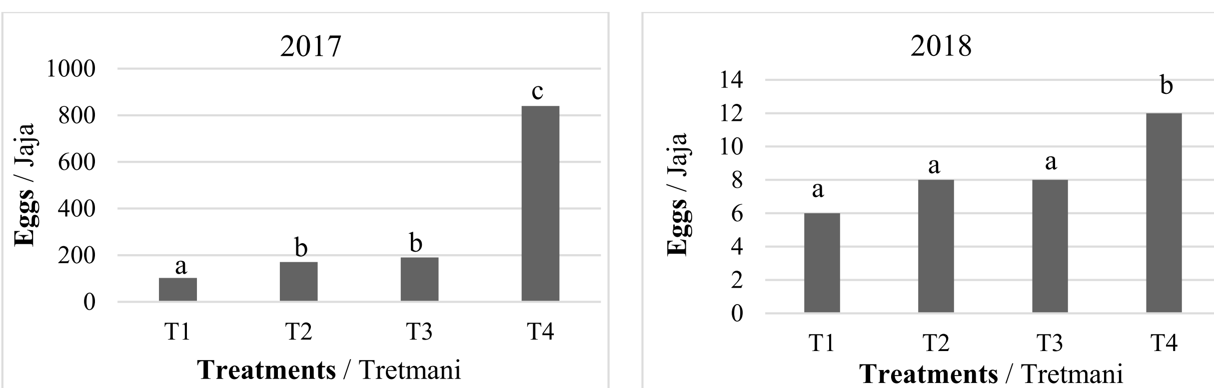


Figure 3. The impact of treatments on the number of *Cacopsylla pyri* eggs in 2017 (left) and 2018 (right). The letters represent a statistically significant difference P ≤0,05 between the treatments.

Grafikon 3. Utjecaj tretmana na brojnost jaja Cacopsylla pyri *u 2017. (lijevo) i 2018. godini (desno). Slova predstavljaju statistički značajnu razliku P ≤0,05 u brojnosti jaja između tretmana.*

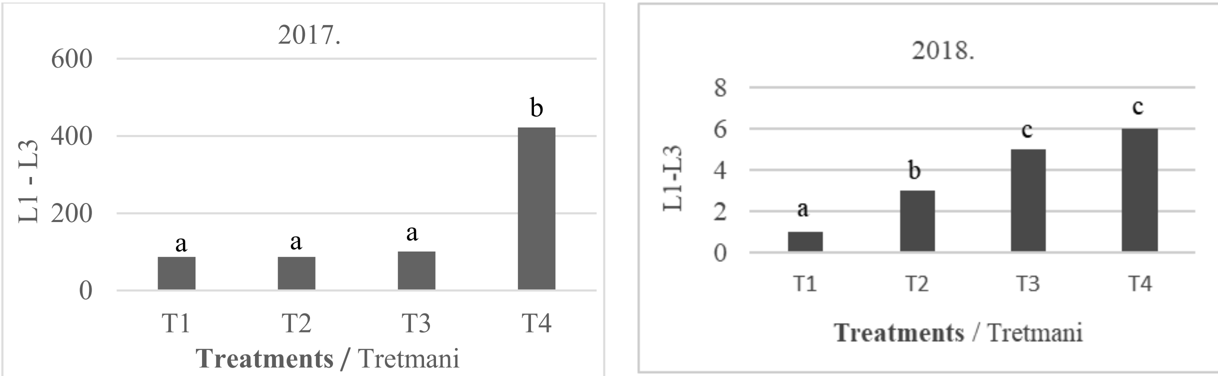


Figure 4. The impact of treatments on the number of *Cacopsylla pyri* nymphs (L1-L3) in 2017 (left) and 2018 (right). The letters represent a statistically significant difference P ≤ 0,05 between the treatments.

Grafikon 4. Utjecaj tretmana na brojnost ličinke Cacopsylla pyri *(L1-L3) u 2017. (lijevo) i 2018. (desno). Slova predstavljaju statistički značajnu razliku P ≤0,05 u brojnosti ličinaka (L1-L3) između tretmana.*

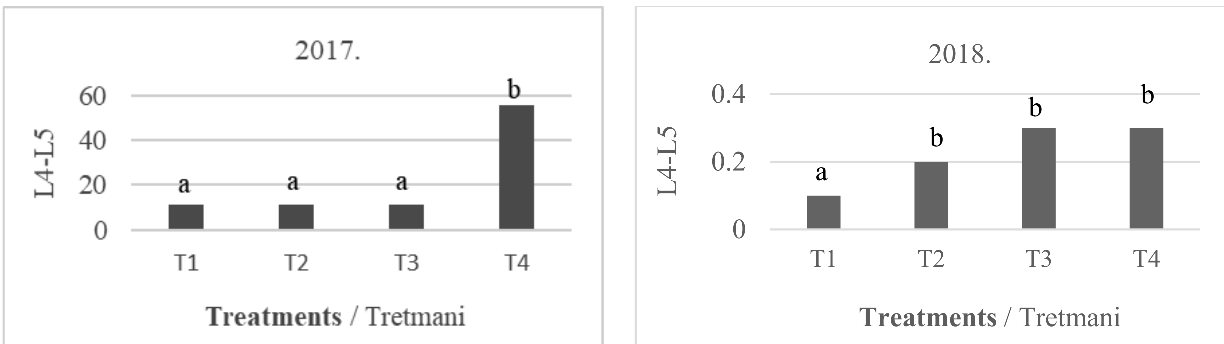


Figure 5. The impact of treatment on the number of *Cacopsylla pyri* nymphs(L4-L5) in 2017 (left) and 2018 (right). The letters represent a statistically significant difference P≤ 0,05 between the treatments.

Grafikon 5. Utjecaj tretmana na brojnost ličinke Cacopsylla pyri *(L4-L5) u 2017. (lijevo) i 2018. (desno). Slova predstavljaju statistički značajnu razliku P ≤0,05 u brojnosti ličinaka (L4-L5) između tretmana.*

The impact of treatments on the number of the pear psylla nymphs L1-L3 varied by years (Figure 4 left and right), which correlates to the results of Kocourek and Stara (2006). In 2017 (Figure 4 left), all treatments had the same impact on number of L1-L3 nymphs and were significantly different when compared to the control treatment, while in 2018 (Figure 4 right) there was a significant difference between T1 and T2 in regard to T3 and T4. Similar results were obtained in the treatments of older nymphs, L4-L5 of pear psylla in the same tested year (Figure 5 right). It is also evident that there was a significantly smaller population of all pear psylla developmental stages in 2018 if compared to 2017 (Figures 3-5). During 2018, higher amounts of precipitation were recorded (Figure 2), especially during the spring and summer months (77.1 mm more precipitation from April till September 2018 when compared to 2017), why we assume that the long period and the amount of rain, as well as the above-average values for summer months (June and July) for our climate area affected not only the population size but also the effectiveness of treatment (Table 3). The nymphs L1-L3 are covered with honeydew, which also protects them from external influences. Honeydew was partly washed away by the rain, as well as the kaolin clay preparation. According to Juillet (2011), research results demonstrated that heavy rains can reduce the pest activity and consequently the pest population. Seven psylla control treatments were performed during 2017, while there were six treatments (Tables 1, 2) during 2018, considering the possibility of weather conditions, as well as critical thresholds. In Croatia, a need for extra psylla control treatments is evident especially during the summer months, being in contrast to Poland, where only several treatments are usually carried out because of their possibility to control the first generation (Jaworska et al., 2012). In Turkey, usual practice against psylla is the appliance of six to eight insecticidal treatments per year (Erler et al., 2013), very similar to the Croatian practice. Puterka et al. (2000) and Daniel et al. (2005) also monitored the effectiveness of preflowering kaolin treatment during the growing season until harvest. In May, the small leaves on the shoot tops were no longer covered with kaolin, and these were the unprotected parts of the tree, where the pear psylla eggs were founded. This was a reason to repeat the kaolin treatments throughout the vegetation, to keep the whole tree completely covered. At the end of June (Daniel et al, 2005), on few kaolin-treated plots the population density observed was slightly lower than the one on the insecticide-treated plots. In our trial, the density of pear psylla in T3 was very similar or identical to the insecticide-treated plots (T1, T2), but it depended on the year (Figs. 3–5). According to Daniel et al. (2005), significant differences were not found between the variously repeated kaolin treatments, so the authors concluded that a triple, preflowering application of kaolin is the most effective control strategy. Moreover, Pasqualini et al. (2002) found that two applications of kaolin, in February and March, provoked a 99–100% reduction of *C. pyri* eggs and nymphs. Our trial proved a long-term duration of kaolin treatments, initiated in May and lasting till August. It demonstrated that the L1–L3 and L4–L5 number of pears psylla nymphs within the same treatment was different from year to year, assuming that the treatment effectiveness largely depended on the climatic conditions during the examined years.

Table 3. Applied treatment efficiency in the control of all developmental stages of pear psylla in 2017 and 2018 at the locality of Agricultural Institute Osijek

Tablica 3. Učinkovitost primijenjenih tretmana u suzbijanju svih razvojnih stadija kruškine buhe u 2017. i 2018. godini na lokaciji Poljoprivrednoga instituta Osijek

Year / *Godina*	Treatment 1 / *Tretman 1*	Treatment 2 / *Tretman 2*	Treatment 3 / *Tretman 3*
2017	95%	90%	71%
2018	84%	47%	37%
Average/*Prosjek*	90%	69%	54%

In this study, T1 (Table 3) demonstrated the highest efficiency of all developmental forms of pear psylla (eggs and nymphs), which implies the preparations used in the integrated protection program. In comparison with T1 (Table 3), T2 (69%) and T3 (54%) had the lower efficiency in both observed years In the Czech Republic, Kocourek and Stara (2006) found that the efficiency of the tested preparations was also different from year to year and that it also differed in the application dates from 92 - 100% for Vertimec, which was also used in our study as a part of T1 and T2. In a study conducted in Serbia (Maričić et al., 2009), diflubenzuron achieved the efficiency of 59%. It explains our efficient results for T1 from 84- 95%, because each active ingredient in this treatment had its own different effectiveness, which also depends on the other abiotic factors (the time of application, year, etc.). Acrinathrin is a synthetic pyrethroid and is a part of active ingredient in T2 with abamectin, which showed lower efficiency (Table 3) in comparison with T1, and which may be the result of cross resistance to pyrethroids. Cross resistance was found in population of *C. pyri* in Europe (Bues et al, 1999.). Considering the previously results (Daniel et al., 2005) which showed satisfactory efficiency of kaolin from 84-98% if applied before flowering, we confirmed that repeated treatments with kaolin after flowering do not increase its effectiveness in controlling other generations of *C. pyri* (Table 3).

CONCLUSION

The decisions on timing concerning the preventive treatments and the choice of plant protection preparations to be used are made on the basis of regular monitoring of pear psylla's developmental stages and crossed critical thresholds, not on the calendar basis, as it is generally used in Croatia. By adhering to the allowed number of plant preparation uses in one year, we have prevented the resistance development and have produced the healthy fruits without harmful pesticide residues. Treatment 1 (integrated treatment) demonstrated the highest efficiency, from 84% to 90%. Kaolin treatment had the lowest efficiency in controlling the pear psylla, from 37% to71%, but it greatly varied depending on the year, similar to all treatments in the trial, which confirms that it should not be applied alone but as a part of an integrated control program. The best term for first application of kaolin is the time prior to the first egg oviposition or preflowering, according to the results from New Zealand, Poland, and north Italy. In this way, the number of the first generation is reduced, as well as a need for pest control of the remaining generations.

ACKNOWLEDGEMENTS

This research was carried out as a part of the VIP Project, funded by the Ministry of Agriculture of the Republic of Croatia.

REFERENCES

1. Abbott, W. S. (1925). A method for computing the effectiveness of an insecticide. *Journal of Economic. Entomology, 18*(2), 265-267. https://doi.org/10.1093/jee/18.2.265a
2. Almaši, R., Injac, M., Almaši, Š., & Spasić, R. (2004). Štetni *i korisni organizmi jabučastih voćaka*. Poljoprivredni fakultet, Departman za zaštitu bilja i životne sredine" Dr Pavle Vukasović".
3. Avinent, L., Llacer, G., Almacellas, J., & Tora, R. (1997). Pear decline in Spain. *Plant Pathology, 46*(5), 694-698. https://doi.org/10.1046/j.1365-3059.1997.d01-57.x
4. Baggiolini, M. (1965). Methode de controle visuel des infestation d'atrhopodes ravageurs du pommies. *Entomophaga, 10*, 222-229. https://doi.org/10.1007/BF02384272
5. Bues, R., Boudinhon, L., Toubon, J.F., Faivre, D., & Arcier, F. (1999). Geographic and seasonal variability of resistance to insecticides in *Cacopsylla pyri* L. (Hom., Psyllidae). *Journal of Applied Entomology, 123*(5), 289-297. https://doi.org/10.1046/j.1439-0418.1999.00350.x
6. Carraro, L., Loi N. Ermacora, N., Gregoris, A., Osler, R. & Hadidi, A. (1998). Transmission of pear decline by using naturally infected *Cacopsylla pyri* L. *Acta Horticulturae, 472*, 665-668. https://doi.org/10.17660/ACTAHORTIC.1998.472.89
7. Ciglar, I. (1989). Integralna zaštita voćnjaka i vinograda. Zrinski, Čakovec, Hrvatska.
8. Civolani, S. (2012). The past and present of pear protection against the pear psylla, *Cacopsylla pyri* L. *Insecticides. Pest Eng. (ed. by F Perveen) Intech*, 385-408.
9. Daniel, C., Pfammatter, W., Kehrli, P., & Wyss, E. (2005). Processed kaolin as an alternative insecticide against the European pear sucker, *Cacopsylla pyri* (L.). *Journal of Applied Entomology, 129*(7), 363-367. https://doi.org/10.1111/j.1439-0418.2005.00981.x
10. EPA (Envionmental Protection Agency) (1999). Kaolin (100104) Fact Sheet. https://www3.epa.gov/pesticides/chem_search/reg_actions/registration/fs_PC-100104_01-Jun-99.pdf
11. Erler F., Pradier T., & Aciloglu B. (2013). Field evaluation of an entomopathogenic fungus, *Metarhizium brunneum* strain F 52, agains pear psylla, *Cacopsylla pyri*, *Pest Management Science, 70*(3), 496-501. https://doi.org/10.1002/ps.3603
12. Glenn, D. M., Puterka,G., Venderzweit, T., Byers, R. E., & Feldhake, C. (1999). Hydrophobic particle films: a new paradigm for suppression of arthropod pests and plant diseases. *Journal of Economic Entomology, 92*(4), 759-771.
13. Glenn, D. M., Prado, E., Erez, A., & Puterka, G.J. (2002). A reflective, processed-kaolin particle film affects fruit temperature, radiation reflection, and solar injury in apple. *Journal of the American Society for Horticultural* Science, *127*(4), 188-193. https://doi.org/10.21273/JASHS.127.2.188
14. Glenn, D. M., & Puterka, G.J. (2005). Particle films: a new technology for agriculture. *Horticultural Review, 31*, 1-44. https://doi.org/10.1002/9780470650882.ch1
15. Higbee, S. B., & Unruh, R. T. (1994, January). Pesticide bioassays on Pear Psylla predators. In *Proceedings of the 68th Annual Western Orchard Pest & Disease Management Conference* (pp. 12-14).
16. Horton, D., R. (1999). Monitoring of pear psylla pest management decisious and research. *Integrated Pest Management Reviews, 4*(1), 1-20.
17. Jaworska, K., Olszak R. W., Labanowska B. H., & Korzeniowski, M. (2012). Efficacy of spirotetramat in the control of pear psylla (*Cacopsylla pyri* L.) on pear trees in Poland. *Journal of Fruit and Ornamental Plant Research, 20*(2), 91-106. https://doi.org/10.2478/v10290-012-0019-3
18. Juillet, J., A. (2011). Influence of weather on flight activity of parasitic Hymenoptera. *Canadian Journal of Zoology 42*(6), 1133-1141. https://doi.org/10.1139/z64-110
19. Kocourek, F., & Stará, J. (2006). Management and control of insecticide resistant pear psylla (*Cacopsylla pyri*). *Journal of Fruit and Ornamental Plant Research, 14* (3), 167-174.
20. Lapointe, S., L. (2000). Particle film deters oviposition by *Diaprepes abbreviatus* (Coleoptera: Curculionidae). *Journal of Economic Entomoogy. 93*(5), 1459-1463. https://doi.org/10.1603/0022-0493-93.5.1459
21. Maričić D., Ogurlić, I., Prijović, M., & Perić, P. (2009). Effectiveness of Azadirachtin (NeemAzal- T/S) in controlling pear psylla (*Cacopsylla pyri*) and European Red Mite (*Panonychus ulmi*). *Peesticide and Phytomedicine*, *24*(2), 123-132. https://doi.org/10.2298/PIF0902123M
22. Nin, S., Ferri, A., Sacchetti, P., & Giordani, E. (2012). Pear resistance to Psylla (*Cacopsylla pyri* L.). *Advances in. Horticultural Science*, *26*(1), 59-74. https://doi.org 10.13128/AHS-12739
23. Pascual, S., Cobos,G., Seris, El., & Gonzalez Nunez, M. (2010). Effects of processed kaolin on pests and non target arthropods in a Spanish olive grove. *Jornal of Pest Science, 83*(2), 121–133. https://doi.org 10.1007/s10340-009-0278-5
24. Pasqualini, E., Civolani, S., & Corelli-Grappadelli, L. (2002). Particle film technology; approach for a biorational control of *Cacopsylla pyri* (Rynchota: Psyllidae) in Northern Italy. *Bulletin of Insectology, 55*(1), 39-42. Corpus ID: 189810300
25. Pree D., Archibald D., Ker, K., & Cole, K. (1990). Occurence of pyrethroid resistance in pear psylla (Homoptera; Psyllidae) populations from southern Ontario. *Journal of Economic Entomology, 83*(6), 2159-2163. https://doi.org/10.1093/jee/83.6.2159
26. Puterka, G., Glenn, D. M., Sekutowski, D.G.,Unruh, T. R., & Jones, S. K. (2000). Progress toward liquidformulations of particle films for insect and disease control in pear. *Environmental. Entomology, 29*(2), 329-339. https://doi.org/10.1093/ee/29.2.329

27. RDC Team. (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
URL http://www. Rproject. org.

28. Schaub, L., Bloesch, B., Aeschlimann, U., & Garnier, G. (2001). Monitoring resistance of pear psylla *Cacopsylla pyri* to amitraz. IOBC WPRS BULLETIN, *24*(5), 151-154.

29. Showler, A. T., & Setamou, M. (2004). Effects of kaolin particle film on selected arthropod populations in cotton in the lower Rio Grande Valley of Texas. *Sothwestern Entomologist 29*(2), 137-146.

30. Sule, S., Jenser,G. & Szita E. (2007). Menagement of pear decline caused by 'Candidatus Phytoplasma pyri' in Hungary. *Buletin of insectology, 60*(2), 319-320.
https://doi.org/10.1.1.582.337

KOMPARATIVNI UČINAK RAZLIČITIH INSEKTICIDA I KAOLINA NA SMANJENU BROJNOST POPULACIJE *Cacopsylla pyri* L.

SAŽETAK

Cacopsylla pyri ***L. (*****Hemiptera: Psyllidae*****) jedan je od najozbiljnijih gospodarskih štetnika kruške u istočnoj Hrvatskoj. Dosadašnje metode suzbijanja štetnika u Republici Hrvatskoj dovele su do rezistentnosti kruškine buhe na pojedine insekticide. Ciljevi dvogodišnjega istraživanja bili su odrediti optimalan broj tretmana s ciljem suzbijanja štetnika na temelju praćenja životnoga ciklusa te utvrditi učinkovitost kaolina u usporedbi s drugim kemijskim insekticidima u četiri različita tretmana (T1: integrirane zaštite bilja (IPM) – diflubenzuron, spirotetramat, abamektin, acetamprid; T2: akrinatrin + abamektin, T3: kaolinska glina, T4: kontrolni tretman). Istraživanje je provedeno 2017. i 2018. godine na pokusnome nasadu kruške starosti šest godina, na tri sorte (Williams, Conference, Abate Fetel) Praćenje populacije štetnika i njezinih razvojnih stadija obavljeno je na dva jednogodišnja izbojka po stablu svake sorte u svim ponavljanjima. Tretman T1 pokazao je najbolje rezultate, s najvećom učinkovitošću od 84 – 95 % ovisno o godini istraživanja, dok je tretman s kaolinom imao najnižu učinkovitost, koja je varirala u odnosu na godinu (37 – 71 %).***

Ključne riječi: **učinkovitost, kaolin, obična kruškin buha, zaštita bilja, integriran*****a zaštita bilja, piretroidi***

(Received on December 7, 2021; accepted on March 1, 2022 – *Primljeno 7. prosinca 2021.; prihvaćeno 1. ožujka 2022.)*