

## Control of *Anthonomus pomorum* (L.) with pyrethrins: Non-target effects of two application rates on arthropod abundance

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### Abstract

*The apple blossom weevil (*Anthonomus pomorum* L.) is a major pest in organic apple growing. For direct control, pyrethrin-based products with known broad-spectrum activity are applied in early spring. Trials in 2022-2023 assessed non-target effects of Spruzit® Neu at 4.6 L/ha, the then-maximum permitted rate (2.3 L/ha per meter canopy height, capped at 2 m, thus 4.6 L/ha maximum). These trials showed limited effects on overall arthropod abundance but a strong, persistent reduction of the pine ladybird (*Exochomus quadripustulatus* L.), an important predator of woolly apple aphid (*Eriosoma lanigerum* Hausmann). By 2024, a regulatory change allowed higher application rates in orchards exceeding 2 m canopy height. This raised the question whether such higher rates cause stronger non-target effects. Field trials in 2024-2025 compared Spruzit® Neu at 4.6 and 6.9 L/ha with untreated controls. Arthropods were sampled in the canopy and herb layers using a BACI design. Both rates reduced total arthropod abundance immediately after treatment, with recovery within 10-16 days. *E. quadripustulatus* populations recovered within 4-5 days, contrasting with the persistent reductions observed in 2022-2023. This difference is likely due to dispersal from surrounding unsprayed orchards. No stronger non-target effects were observed at the higher rate. However, if efficacy against *A. pomorum* is considered sufficient, the lower rate is preferable due to reduced chemical load and costs.*

**Keywords:** Pyrethrins, non-target effects, *Anthonomus*, *Exochomus*, organic apple orchards

### Introduction

Comprehensive pest management strategies should consider not only the direct benefits and costs of pesticide use, but also potential non-target effects on functional and overall biodiversity, the costs of measures to reduce pest pressure, and the costs of risk-mitigation measures. This is particularly important when broad-spectrum pesticides are applied. However, incorporating these additional factors into decision-making requires robust empirical data, which are often unavailable. In German organic apple production, broad-spectrum pesticides are rarely used. However, for direct control of the apple blossom weevil (*Anthonomus pomorum* L.) in spring, pyrethrin-based products with known broad-spectrum activity remain the only option. As this treatment is applied early in the season, at the end of dormancy, it was assumed that few other arthropods are active in the orchard at that time, thereby limiting potential non-target effects. This assumption was addressed in field trials conducted in several organic apple orchards in the Lake Constance region in 2022 and 2023, where Spruzit® Neu was applied at the maximum permitted rate at that time (4.6 L/ha based on 2.3 L/ha per m canopy height, capped at 2 m). These trials indicated no strong effects on total arthropod abundance or species richness, nor on functional groups of beneficial arthropods like predatory bugs, spiders, or parasitoid wasps. However, a pronounced and persistent negative effect was observed for the pine ladybird (*Exochomus*

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*quadripustulatus* L.), a key predator of woolly apple aphid (*Eriosoma lanigerum* Hausmann) in spring (Mols 1995, 2000), which showed no recovery in the treated plots during early-season monitoring (Maisel *et al.* 2024). Following a regulatory change in 2024, the limit of 2.3 L/ha and m canopy height remained in place, but the capping at 2 m was removed, allowing higher application rates per hectare in orchards with a canopy height of more than 2 m. This change raises the question whether increasing pyrethrin application rates leads to stronger or more persistent non-target effects. To address this question, follow-up field trials were conducted in 2024 and 2025, comparing the former maximum application rate with a higher rate and untreated controls.

## Material and Methods

Field trials were conducted in 2024 and 2025 in five organic apple orchards in the Lake Constance region, with commercial or traditional orchards and forest in the immediate surroundings. Treatments included applications of Spruzit® Neu at 4.6 and 6.9 L/ha, each at a water volume rate of 1.000 L/ha, and untreated controls, each established on plots of approximately 0.5 ha in size. Applications were carried out at the recommended timing for the control of *A. pomorum*. In 2024, treatments were applied site-dependently between 8 and 10 March, and in 2025 on 20 March, corresponding to BBCH 52-53 (end of bud swelling to bud burst). Arthropods were sampled following a before–after–control–impact (BACI) design from one day before application until mid-May. Arthropods were collected in the canopy using beating trays (3 samples/plot, 33 trees/sample), in the herb layer using sweep nets (30 sweeps in two adjacent rows/plot). Generalized linear mixed models were used to assess the effects of treatments interacting with time (days relative to treatment) on total arthropod abundance and key taxonomic groups. Data from both years were combined to identify consistent treatment effects. Data were separated into impact (pre-treatment to treatment day) and recovery (post-treatment) subsets. Treatment impacts were assessed by comparing marginal trends between the pre-treatment sampling and the sampling immediately following application. Significant impacts were identified by comparing marginal trends between pre- and post-treatment sampling. Recovery was assumed when no significant differences to controls were detected. Post-hoc tests used Tukey adjustment.

## Results and Discussion

Before treatment, the most common non-target organisms in the canopy in both years were Araneae ( $\bar{x}$  8.42 Ind./sample), Coccinellidae ( $\bar{x}$  4.19), and Nematocera ( $\bar{x}$  2.44), representing 88% of catches. In the herb layer, Brachycera ( $\bar{x}$  31), Nematocera ( $\bar{x}$  15.8), and Auchenorrhyncha ( $\bar{x}$  9.93) dominated (95% of catches). These abundant groups were most likely affected. Both application rates had comparable effects. In the canopy, total abundance decreased by 72% at 4.6 L/ha, 68% at 6.9 L/ha, and 34% in the untreated control, with significant differences compared to the control persisting for 15 days at 4.6 L/ha and for 16 days at 6.9 L/ha. In the herb layer, abundance declined by 85% at 4.6 L/ha, 86% at 6.9 L/ha, and 40% in the control, recovering within 10 days. Temporal declines observed in control plots likely reflect natural population fluctuations, weather-related variation in insect activity between sampling dates, and inherent stochastic sampling effects. Among beneficial arthropods, Araneae and Coccinellidae were common at application time, with 97% of Coccinellidae belonging to *E. quadripustulatus*, an important early-season predator of woolly apple aphid (*E. lanigerum*). Parasitoid wasps and predatory bugs were rare. Spiders declined in all treatments (control: -23%, 4.6 L/ha: -52%, 6.9 L/ha: -42%), with no significant differences between treatments. In contrast, *E. quadripustulatus* declined sharply at both rates: -97% at 4.6 L/ha, -99% at 6.9 L/ha, and -9% in the control, but recovered within 4-5 days, with population increases in the treated plots and decreases in the control. This

fast recovery observed in 2024-25 suggests immigration from adjacent control plots and surrounding unsprayed orchards, as reproduction of this univoltine species is slow, with the new generation not emerging until summer (Sengonca 2003 and personal observations). In contrast, during the trials conducted in 2022-23 with 4.6 L/ha, no such immigration pattern was evident, resulting in a prolonged reduction of *E. quadripustulatus*. At that time, differences disappeared after ~2.5 weeks through population decline in the control, while populations in treated plots remained low throughout the monitoring period, showing no recovery (Maisel *et al.* 2024). The increased dispersal in 2024-25 compared to 2022-23 may be explained by a higher population density ( $\bar{x}$  4.11 vs.  $\bar{x}$  2.41 Ind./sample before treatment), smaller plot sizes ( $\bar{x}$  0.5 ha vs.  $\bar{x}$  1.25 ha), lower food availability, or combinations thereof. Food scarcity facilitates emigration of ladybirds (Hodek & Evans 2012). As the treated plots contained very few *E. quadripustulatus* post-treatment, intraspecific competition for food was likely reduced, making these plots less competitive environments and thus attractive to immigrants from nearby populations.

When comparing the effects on non-target arthropods of both application rates, all analyses led to a consistent conclusion: The overall impact of Spruzit® Neu was comparable at 4.6 L/ha and 6.9 L/ha. Recovery periods were largely similar and generally occurred rapidly in both treatments, typically before the start of apple flowering. The relatively small plot size (0.5 ha) and proximity to untreated source habitats like surrounding commercial orchards, traditional orchards, and forest likely facilitated recovery through immigration. Additionally, emergence of dormant arthropods that were inactive during treatment may have contributed to recovery. Recovery dynamics may differ in larger-scale applications or more isolated orchards. Highly susceptible groups already showed strong responses to the lower rate, indicating that 4.6 L/ha exceeded their toxicity threshold, while less susceptible groups may remain below their threshold at both rates. Overall, no evidence was found that the higher rate caused stronger effects on non-target arthropods. If efficacy against the apple blossom weevil (*A. pomorum*) is comparable between both application rates, the lower application rate would be preferable, as it reduces chemical load and associated costs for the grower. This should be confirmed through dedicated efficacy studies.

## Acknowledgements

We thank the Ministry of Food, Rural Affairs and Consumer Protection of Baden-Württemberg for funding this research and the fruit growers who participated in the study.

## References

- Hodek, I., Evans, E. (2012). Food Relationships. In *Ecology and Behaviour of the Ladybird Beetles (Coccinellidae)* (ed. Hodek, I., H. F. van Emden, Honěk, A.). Wiley, Hoboken
- Mols, P.J.M. (1996). Do natural enemies control woolly apple aphid? *Proc. Int. Conf. Integr. Fruit Prod., Poland 28 August-2 September 1995* 19(4): 203-207.
- Mols, P.J.M. (2000). Simulation approach of the role of the pine ladybird (*Exochomus quadripustulatus* L.) and the earwig (*Forficula auricularia* L.) in controlling the woolly apple aphid (*Eriosoma lanigerum* Haussmann). *Proc. Neth. Entomol. Soc.* 11: 129-134.
- Maisel, H., Schluchter, M., Kienzle, J., Esenova, G. (2024). Development of an Extended Decision Threshold for the Application of Plant Protection Products in Organic Fruit Growing: A Case Study on the Control of *Anthonomus pomorum* (L.) with Pyrethrins. *Proc. 21st Int. Conf. Org. Fruit-Grow., Filderstadt 2024.02.19-21. Ed. FOEKO e.V. 2024*: 121-123
- Sengonca, C., Arnold, C. (2003). Development, predation and reproduction by *Exochomus quadripustulatus* L. (Coleoptera: Coccinellidae) as predator of *Pulvinaria regalis* Canard (Homoptera: Coccidae) and its coincidence with the prey in the field. *J. Plant Dis. Prot.* 110(3): 250-262