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Lobesia mating disruption by pheromone mesofiber dispensers

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Lobesia botrana (Lepidoptera: Tortricidae) is a permanently established viticultural insect pest in all vinegrowing countries. According to recent findings, sex pheromones dispensed from electrospun mesofibers serve as environmentally compatible, biodegradable mating disruptants of an innovative type. Their disruptive effects in vineyards last for a minimum of 7 weeks per application, equivalent to one *Lobesia* flight period. Instead of manual application, mesofiber dispensers offer the advantages of (1) mechanical deployability, (2) hydrolytical and/or enzymatic self-degradability, (3) unnoticeable ecotoxicological impact on nontarget organisms, (4) added savings by reduced handling costs, and (5) a fully "green" approach along the entire process chain from synthesis of the ingredients to biodegradation in the vineyard.

Keywords: *Lobesia botrana*, mating disruption, mesofiber dispensers, sex pheromone, *Vitis vinifera*

1 Introduction

Due to considerable input by entomologists (Götz, 1939) and pheromone chemical ecologists (Roelofs et al., 1973; Buser et al. 1984; Neumann, 1990; Breuer et al., 2013) the field of mating disruption of destructive vineyard insects has reached its present state of undisputed maturity. Unfortunately, the favourably low environmental impact of pheromone technology in combination with novel dispenser technology has not been appreciated to the degree it deserves. At the expense of continued residue formation in the environment and build-up of resistant insect strains by conventional toxic sprays, management of vineyard insects partially still continues along established lines, in spite of growers' statements to the contrary. Who is to blame? Is it the reluctance to postpone investments in view of economic pressures, is it just the diffuse fear of new technologies, or the result of all-too comfortable mindsets?

In an effort to show what can be accomplished in *Lobesia* management, advances of chemical ecology, polymer technology and mechanization efforts are combined. The results reported in this paper merge into an integrated concept. This can be seen as a step towards achieving precision organic viticulture where only the minimum of pheromone required at the right time and in the right place is being applied. The resulting mating disruption process and, consequently, the greatly reduced level of larval infestation by *Lobesia* of the grapes so produced is under constant, careful monitoring.

2 Material and Methods

Sex pheromone of *L. botrana*, (*E,Z*)-7,9-dodecadienyl acetate, has been purchased from the specialty supplier Trifolio-M Lahnau, Germany, and incorporated into the mixed aliphatic-aromatic Ecoflex® polymer supplied by BASF AG as the well known and widely used biodegradable co-polyester material in manufacturing plastic shopping bags. Charging this polymer material with 33 % (w/w) of sex pheromone occurred under electrospinning conditions according to procedures reviewed by Greiner and Wendorff (2007) and described

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further by Hellmann et al. (2011) and by Hummel et al. (2011). Fiber diameters ranged between 600 and 3500 nm and were therefore called "mesofibers". These mesofibers contained the sex pheromone predominantly in the fiber core from where it was controllably diffusing out through the fiber walls with zero order kinetics. Resulting nonwoven mats of pheromone-mesofiber dispensers were fixed onto polyethylene hail protection netting as a sturdy carrier. This was fastened manually to the metal wire lines holding the grape vines in place. The mating disruption plots were laid out in a large vineyard area of State Institute of Viticulture and Enology, Freiburg, Germany. The area was divided into several sections where untreated negative controls, positive controls of the commercially available Shin-Etsu "spaghetti type" polymer and mesofiber plots were situated side by side. Individual distances between plots were at least 50 meters in order to avoid any unwanted carryovers of pheromone vapours between the sections. For measuring the disruptive effects, the smart approach of Doye (2006) with a central field monitoring station in a metal wire screened walk-in field enclosure was employed. In both untreated and treated sections of the vineyard, 40 males (from an artificial rearing program) were released *inside* the central Doye enclosure. Those males in undisrupted sections of the vineyard would invariably orient towards small screened cages containing artificially reared virgin calling females. The males in search for virgin females would be trapped on sticky delta trap surfaces and counted. Similarly released males in disrupted areas, however, would be disoriented and never reach the virgin female trap. So the ratio of males caught in disrupted versus undisrupted sections of the vineyard was proportional to the disruption level achieved at a certain time and space. These experiments were repeated several times and constantly provided a true picture of the disruption status achieved. Experiments were continued until there was no statistical difference any more between control and treated fields. Two series of experiments were compared, one with unmodified, one with modified and longer lasting fibers charged according to advanced procedures of Bansal et al. (2012). For ease of comparison, the recapture results obtained with untreated controls are arbitrarily set at 100% recapture rate.

3 Results and Discussion

Results obtained for both the novel mesofiber and commercial Isonet "spaghetti type" dispensers appear side by side in Fig. 1a and are easily compared. The unmodified original mesofibers in this experiment retain their biological effect for up to 4 weeks. In a second series of tests, modified mesofibers spiked with an extra charge of preformulated microencapsulated pheromone added to the spinning solution according to Bansal et al. 2012, are tested in Fig 1b and show an extension of the disruptive affect uninterruptedly lasting for up to seven weeks. Please note the inverse relationship between male recapture rates and disruption effects by female sex pheromone. The graph above the mesofiber column is a EM picture of the mesofiber network. Further prolongation of the effect appears likely through modification of the electrospinning parameters selected. Mesofibers and the commercial variety Isonet® are equally effective. Mesofibers, however, have the *added* dual advantage of (1) complete biodegradability (acc. to Witt et al. 2001) and (2) mechanizability of the process not needing any manual (and therefore expensive) field work. Mechanization of mesofiber deployment is possible through distribution of the mesofiber material from an ERO grapevine shoot binder machine which can handle several unrelated mechanical cultivation tasks simultaneously. The pre-fabricated yarn holding the vines in place is prespun with enough mesofiber material to provide a continuous source of pheromone disruptant , both over time and space.

4 Conclusions

In conclusion, mesofibers provide an entirely novel technology approach (Hummel et al., 2011; Breuer et al., 2013) with room for future improvement towards longer lasting residue-free mating disruption. Mesofibers are a welcome tool for insect management in precision organic viticulture.

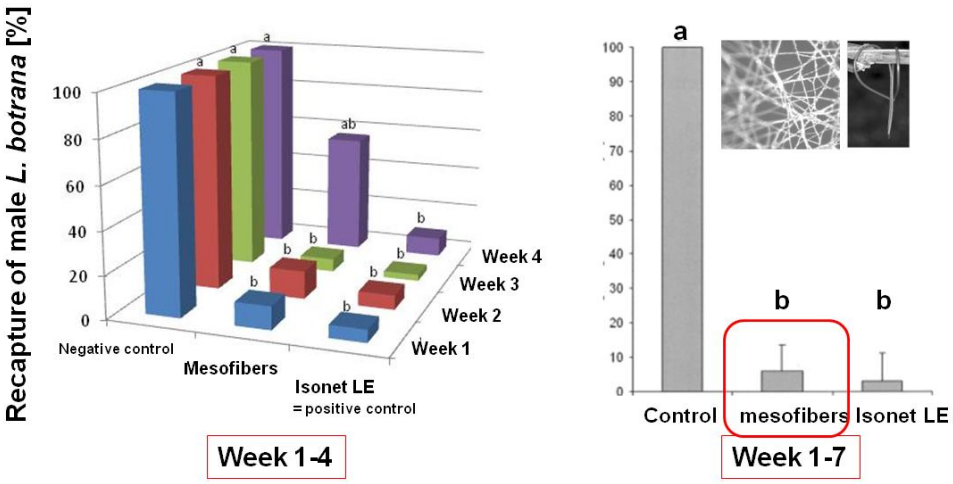

Figure 1a, 1b Recaptures in % of male *L. botrana* as a measure for the effectivity of mesofibers in comparison to a commercially available ISONET LE preparation

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