Investigation on the invasiveness of Cumbasil® Mite on the red chicken mite (*Dermanyssus gallinae*)

Roderich Garmeister, Anne Schulz-Beenken and Marc Boelhauve

Introduction

At the Department of Agriculture of the South Westphalia University of Applied Sciences (SWUAS), a series of investigations was carried out on the effect of a compound of microminerals of natural origin (Cumbasil® Mite, Witteler, Germany) on the red chicken mite. After determining the particle size distribution and the running behaviour on artificial and natural surfaces (cf. GARMEISTER & BOELHAUVE 2019a), as well as light microscopic examinations (cf. GARMEISTER & BOELHAUVE 2019b) scanning electronic images were taken. First, the extremities and the head were examined with regard to damages to the cuticle and possibly blocked joints.

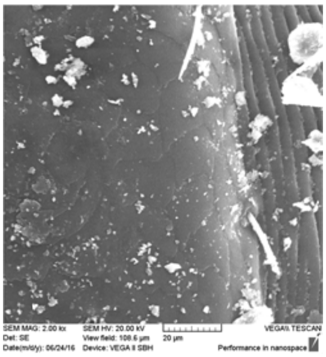
In this study, the invasiveness of Cumbasil® Mite was to be assessed using electron microscopic images in order to assess the initial suspicion of a biocidal effect.

Material & Methods

In order to test the effectiveness of the prophylactic control by Cumbasil® Mite, red chicken mites were collected in a laying hen farm (Bioland, NRW, Germany) by nocturnal non-invasive mite traps, which were further investigated on the same day. Subsequently, the red chicken mite was determined with the corresponding stages of development. For the electron microscopic examination, a sample of the Cumbasil® Mite preparation was recorded 100 times, 500 times and 2000 times in the magnifications (Sputter Coater Model S 150 B, Edwards; Scanning Electron Microscope for SEM, Model VEGA SBH, Tescan) after determining a sufficient intrinsic conductivity in the SEM mode (secondary electron microscopy). Both mites with Cumbasil® Mite and control mites from the dorsal and ventral view were first vaporized with gold in the sputter and recorded in various magnifications up to 5,000 times. The surfaces of the animals were examined for changes and peculiarities.

Results

Using electron microscopy up to a magnification of 5,000 times, no changes could be detected on the surface (cuticle) of the chicken mites. Cumbasil® Mite adhesion can be described as superficial, non-invasive (Figs. 1 and 2). Some of these particles have adhered even after simple treatment with a drop of water. Most of the particles were detached without mechanical impact. Also with the simply washed animals no penetrated particles and/or injuries of the Kutikula were to be observed.



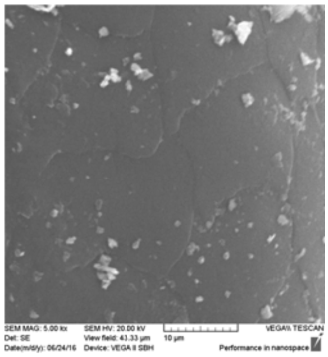


Fig. 1 (left): Electron microscope image of a mite from the Cumbasil® Mite group. Dorsal view. Magnification 2,000x. **Fig. 2** (right): Same view. Magnification 5,000x.

Discussion

MEWIS and ULRICHS (1999) reported that the kieselgur particles were difficult to remove when washing or brushing off their experimental animals (grain and flour beetles). Electron microscopic images showed the invasive effect of these particles (Fig. 3).

Fig. 3: Image from the publication of Mewis and Ulrichs (1999). Original signature: REM. Detail of the Coxa yon T. molito. Diatomic particles (Fossil Shield ®) sunk into the cuticle.

Chicken mites are significantly smaller than flour beetles, but a larger photo (5,000 times) shows no damage to the cuticle or penetrated cumbasil particles (Figs. 1 and 2).

Furthermore, the typical wax efflorescence is missing, as it has been described several times with invasive/biocidal particles (MEWIS and ULRICHS, 1999; STADLER et al., 2017). A comparison of Fig. 2 with Fig. 4 shows this. The spherical wax blooms clearly visible in Fig. 5 at 7,000x magnification should also be visible in Fig. 2 at 5,000x magnification.

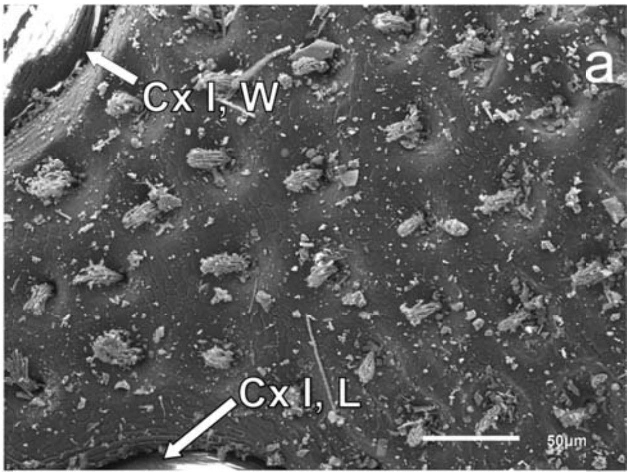


Fig. 4: Diatomic soil on the front part of the breastplate of a rice grain beetle. Magnification 400x. Picture taken from the publication by Stadler et al. (2017). Original signature: Prosternum of S. oryzae exposed to 500 ppm DE.

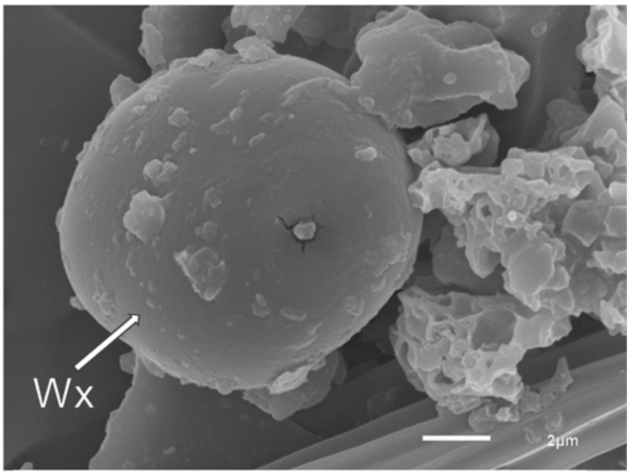


Fig. 5: Wax efflorescence after contact with aluminium powder in a rice grain beetle. Magnification 7,000x. Picture taken from the publication by Stadler et al. (2017). Original signature: SEM image of a wax bloom (Wx) on the abdominal sterna of a S. oryzae individual exposed to 500 ppm NSA treated wheat

In addition, the average particle size of Cumbasil® Mite was 63 µm (cf. GARMEISTER & BOELHAUVE 2019b), whereas the average size of diatoms used by STADLER et al. (2017) was 10 µm. The aluminum plates had a thickness of 45 nm and a bimodal length distribution with the larger portion at 1.5 µm and the smaller portion at 350 nm (0.35 µm). The aluminium powder was significantly more effective against rice grain beetles than diatomaceous earth (STADLER et al., 2017)

This renewed indication that the biocidal effect depends primarily on the particle size, as well as the absence of the typical invasive features (penetrated cuticle, wax efflorescence) in the test series carried out here, support the assumption that the preparation Cumbasil® Mite has no biocidal effect. On the basis of the electron microscopic images, it can be assumed that Cumbasil® Mite has no direct effect on the body of chicken mites in the form of injuries followed by dehydration. This is also underlined by the simple observation of the continuing activity of the mites, which remained viable even after pollination with Cumbasil® Mite (cf. GARMEISTER & BOELHAUVE 2019c).

On the basis of the above and mentioned investigations, a purely mechanical mechanism of action of the Cumbasil® Mite product can be assumed.

Financial support: This work was financed by the company Witteler (Rüthen, Germany) and was subject to the requirements of good scientific practice.

References

Garmeister, R. & Boelhauve, M. (2019a): Investigation on the influence of Cumbasil® Mite on the movement of the red chicken mite (Dermanyssus gallinae) on feathers. Research Notes, No. 5/2019, SWUAS

Garmeister, R. & Boelhauve, M. (2019b): Investigation on the size distribution of Cumbasil® Mite in comparison to other silicate preparations for the control of the red chicken mite. Research Notes, No. 3/2019, SWUAS

Garmeister, R. & Boelhauve, M. (2019c): Investigation of the influence of Cumbasil® Mite on the migration activity of the red chicken mite (Dermanyssus gallinae). Research Notes, No. 6/2019, SWUAS

Mewis, I., Ulrichs, C. (1999): Wirkungsweise amorpher Diatomeenerden auf vorratsschädliche Insekten. Untersuchung der abrasiven sowie sorptiven Effekte. Az. Schädlingskunde / J. Pest Science 72 (1999), Blackwell Wissenschafts-Verlag, Berlin, 113-121

Stadler, T., López García, G.P., Gitto, J., Buteler, M. (2017): Nanostructured alumina: Biocidal properties and mechanism of a novel insecticide powder. Bulletin of Insectology 70 (1): 17-25