

Alternative phytosanitary products against to white muscardine in *Bombyx mori* L. (Lepidoptera: Bombycidae)

Produtos fitossanitários alternativos contra a calcinose em Bombyx mori L. (Lepidoptera: Bombycidae)

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ABSTRACT: This work aimed to evaluate the effects of the products Biogermex[®], Agro-mos[®], Soil-Set[®] and Planta Clean[®] on the development of white muscardine in *Bombyx mori*. Products have been tested at two stages for effects on biology of caterpillars and on silk production (1), and then they were evaluated to know their potential in the prevention/control of white muscardine (2). Products were sprayed on mulberry leaves (preventive treatment) and also on the integument of silkworms (curative treatment). At the first stage, the products were applied on four consecutive days, in one of the daily feeds. Planta Clean[®] — curative treatment — and Soil-Set[®] — preventive treatment — caused mortality in 63.3% and 30% of silk worms, respectively. The fungus *Beauveria bassiana* was inoculated at the concentration 5×10^7 conidia/mL on the leaves and insects. The products were applied three hours after application on the fungus, in a single application, and also for four days in the other groups. A group of silkworms sprayed only with the fungus served as control. Biogermex[®] — curative treatment applied once and for four times — was the most effective, reducing mortality by 25 and 26.7%, respectively, as compared with the control group. None of the evaluated products acts preventively against white muscardine.

KEYWORDS: silkworm; *Beauveria bassiana*; disease control.

RESUMO: Este trabalho objetivou avaliar os efeitos de produtos Biogermex[®], Agro-mos[®], Soil-Set[®] e Planta Clean[®] no desenvolvimento da calcinose branca em *Bombyx mori*. Os produtos foram testados em duas etapas: efeitos sobre a biologia e produção de seda pela lagarta (1) e, em seguida, em função do seu potencial na prevenção/controlado da calcinose branca (2). Os produtos foram pulverizados sobre as folhas de amoreira (tratamento preventivo) e sobre o tegumento das lagartas (tratamento curativo). Na primeira etapa, os produtos foram aplicados durante quatro dias consecutivos, em uma das alimentações do dia. Planta Clean[®] — tratamento curativo — e Soil-Set[®] — tratamento preventivo — causaram mortalidade em 63,3 e 30% das lagartas, respectivamente. O fungo *Beauveria bassiana* foi inoculado na concentração 5×10^7 conídios/mL sobre folhas e insetos. Os produtos foram aplicados três horas após o fungo, em uma aplicação, e também por quatro dias em outro grupo. Um grupo de lagartas pulverizadas apenas com fungo serviu como controle. Biogermex[®] — tratamento curativo aplicado uma e quatro vezes — foi o mais eficiente, reduzindo a mortalidade em 25 e 26,7% respectivamente, em relação ao grupo controle. Nenhum dos produtos avaliados atuou de forma preventiva contra muscardina branca.

PALAVRAS-CHAVE: bicho-da-seda; *Beauveria bassiana*; controle de doença.

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INTRODUCTION

Sericulture is an agro-based activity that employs relatively simple and low-tech equipment and facilities. Moreover, the conditions for rearing the insects (humidity around 70% and temperature of 25°C) are favorable to the development of pathogens that can compromise the whole rearing, especially bacteria, fungi and viruses (PORTO et al., 2005; POTRICH et al., 2007).

White muscardine, the main fungal disease associated with *Bombyx mori*, is caused by the fungus *Beauveria bassiana* Bals. (Vuill.), especially in the first instars, and leads to larval death about six days after infection (AMARAL; ALVES, 1979; HANADA; WATANABE, 1986; KUMAR et al., 1999).

Preventive measures, such as disinfecting the premises and equipment, are taken before and after each silkworm batch is removed, followed by the spraying of a 3% formaldehyde solution (HANADA; WATANABE, 1986; ZANETTI, 2011). It should be noted that, even in the absence of silkworms, and despite all measures of disinfection of the premises and equipment, there is still contamination by microorganisms, although in lower indices, as claimed by MARGATHO et al. (2012).

In this way, PARES; ALVES (2016) reviewed some alternatives to control silkworm white muscardine in *B. mori* silkworms. Besides synthetic fungicides and disinfectants, authors observed some studies with plant extracts and other natural products are being evaluated, and some of them have great potential for use. Therefore, RAJAGOPAL et al. (2014) observed the efficacy of a disinfectant based on chlorothalonil 1.6% (Kavach®) to prevent white muscardine in *B. mori* larvae. Insects infected and treated with the product showed more than 60% survival.

Aquous extracts of *Argemone mexicana*, *Terminalia arjuna*, *Syzygium cumini* and *Annona squamosa*, plants with antifungal properties, were evaluated in the prevention of the white muscardine. *B. mori* larvae were pulverized with *B. bassiana* conidial suspension, followed by extracts application. A reduction in insect mortality by fungus and an increase of cocooning and pupation rates were observed in treated insects (CHAVAN et al., 2011). Also, aqueous extracts of *Azadirachta indica*, *Parthenium hysterophorus*, *Ocimum sanctum* and *Pongamia pinnata* have been tested on the survival of *B. mori* infected with *B. bassiana*. A decrease of mortality and an increase of weight in silkworms were verified (NAIK et al., 2016).

Turbinaria conoides algae extract presented antifungal properties when tested *in vitro* on *B. bassiana*. Also, it was evaluated *in vivo* on *B. mori* larvae, previously infected with *B. bassiana*. It was observed the antifungal activity of *T. conoides* extracts, mainly at 2,000 µg/mL. There were up to 85% of cocooning at higher concentrations and only 12% of cocooning in the group treated with *B. bassiana* (KUMARI et al., 2011).

Recently, it was shown that alternative phytosanitary products (biofertilizer, resistance inducers and plant-based products) may be affected by many biological parameters of *B. bassiana*, especially the conidial viability (MAMPRIM et al., 2014), though their effect on *B. mori* silkworms is unclear as far as larval development and silk production are concerned. In this sense, this study aimed to evaluate the potential of alternative phytosanitary products on the development of white muscardine in *B. mori*.

MATERIAL AND METHODS

Insects

Third-instar *B. mori* silkworms were used in the study (Bratac Fiação de Seda, Guaraniáçu, PR, Brazil). In the laboratory, the silkworms were kept under controlled conditions (26 ± 1°C, photoperiod 12 h) in plastic boxes, with the bottom lined with paper towel and closed with screened lids. The silkworms were fed with mulberry leaves collected in the morning, and kept in plastic bags at a temperature of 10°C. Food was provided three times a day, after removal of waste and cleaning of the boxes, until the silkworms would reach the fourth instar, when they were used in the bioassays.

Alternative phytosanitary products

The experiments were carried out by using products previously selected and assessed by MERTZ et al. (2010) and MAMPRIM et al. (2014) as being incompatible with the fungus *B. bassiana*. The products were used at the concentrations recommended by the manufacturer (Table 1).

Fungus

The fungus *B. bassiana* was used as a causative agent of white muscardine, particularly the isolate UNIOESTE 4, from Coleção de Fungos Entomopatogênicos do Laboratório de Biotecnologia Agrícola, Universidade Estadual do Oeste do Paraná in Cascavel, Paraná.

The fungus was grown in culture medium for conidia production (yeast extract 5 g, salt mixture 4.6 g, glucose 10 g, agar 20 g and water 1,000 mL), and incubated at 26°C for a 12-hour photoperiod for eight to ten days. Then, the conidia were collected by scraping the surface of the culture medium and stored in a sterile glasstube. After that, 10 mL of sterile distilled water + Tween 80 (0.01%) was added and serial dilutions were performed for quantification in a Neubauer chamber in order to obtain the concentration of 5×10^7 conidia/mL, which was previously determined to cause approximately 70% mortality in silkworm larvae.

Experiments

The study was conducted at two stages:

1. Products were evaluated for effects on insect biology and silk production;
2. They were tested for their preventive/curative potential on white muscardine.

Products were applied on the mulberry leaves (preventive action) and on the integument of the silkworms (curative action). The products were applied with a 500 mL manual sprayer, and the applications were performed once a day (about 4 mL/repetition). In the control, only sterile distilled water + Tween 80 (0.01%) was sprayed. After application, the silkworms were kept in a temperature-controlled room, as described before. In order to evaluate the effects of alternative products on the biology of *B. mori* and silk production, insects received the products for four consecutive days.

Each treatment used four groups (repetitions) with 15 insects each.

The variables analyzed were: silkworms daily mortality, number of formed cocoons, mean cocoon weight at seven days after formation, mean cocoon shell weight and liquid silk percentage. For such determinations, the cocoons obtained in each treatment were weighed, and then the average unit weight was calculated (g). After that, the cocoons were sectioned longitudinally to extract the pupae and to weight the cocoon shell, and also to determine the mean unit weight of the cocoon shell (g). The liquid silk percentage was calculated with the equation 1 by OLIVEIRA et al. (2010):

$$\text{Liquid silk percentage (\%)} = \left[\left(\frac{\text{empty cocoon weight}}{\text{full cocoon weight}} \right) \times 100 \right] - 24\% \quad (1)$$

Bioassays were developed in a completely randomized experimental design and in a 4 × 2 factorial arrangement, seeking to verify interactions between the four products being tested and the two actions (preventive or curative).

For evaluation of the effects of the products on white muscardine, 5 mL aliquots of the conidia suspension (5 × 10⁷ conidia/mL) were applied on the mulberry leaves with an airbrush coupled to an air compressor with constant

pressure (0.8412 kgf/cm²), while a Potter spray tower was used for the silkworms (0.703 kgf/cm²). Then, the products were applied as preventive and curative treatments. Furthermore, for both treatments, the products were assessed in a single-dose application, and then in repeated applications for four consecutive days.

The experiment used a completely randomized design and a 4 × 2 × 2 factorial arrangement, seeking to check interactions between the four products being tested, the two actions, and the two administrations (one administration only or a daily dose for four consecutive days). In the control, only sterile distilled water + Tween 80 (0.01%) was sprayed. There was also a treatment which used fungus suspension alone (5 × 10⁷ conidia/mL).

The evaluation was carried out daily, by removing the dead insects after immersion in a solution of 70% alcohol and distilled water; they were kept in an incubation chamber for confirmation of the causal agent of mortality. The number of formed cocoons in each treatment was also evaluated.

The hypothesis of normality of the data was confirmed by the Kolmogorov-Smirnov-Lilliefors test (p > 0.05). Then, the Dunnett's test (p < 0.05) was used to compare the means of the control and fungus-only group, with data from the groups with alternative phytosanitary products. All statistical analyses were performed with the Statistica 7.0 software (StatSoft, 2004)

RESULTS AND DISCUSSION

Effect of alternative phytosanitary products on the biology of *B. mori* and silk production

When the products were applied to the mulberry leaves to feed the silkworms, there was 30% mortality in the treatment with Soil-Set®. There weren't significant differences between other treatments and control (Table 2).

Soil-Set® is a biofertilizer resulting from the fermentation of organic waste; it has a complex composition of essential nutrients to plants, and some heavy metals that are susceptible to bioaccumulation and, therefore, toxic to insects.

Table 1. Alternate phytosanitary products, mode of action and recommended concentration, used to evaluate the effect of the products on the development and silk production of *B. mori* silkworms.

Product	Composition ¹	Mode of Action ¹	Recommended concentration/ha ²
Planta Clean®	Vegetals extract and mineral salts	Fungicide	25 mL/1 L H ₂ O
Soil-Set®	Natural enzymes	Resistance inducer	100 mL/200 L H ₂ O
Agro-Mos®	Celular wall from <i>Saccharomyces cerevisiae</i> /mannanligosaccharides	Resistance inducer	200 mL/100 L H ₂ O
Biogermex®	Citric extracts	Resistance inducer	200 mL/100 L H ₂ O

¹Available information on the label of the products; ²Concentration recommended by the manufacturer.

These features may account for the high mortality rate found in the treatment with this product and, therefore, explain the results. In addition, as any liquid biofertilizer nowadays, Soil-Set® has insecticide, insect-repellent, acaricide, and fungicide action (GALLO et al., 2002).

This contrasts from the results with the product Soil-Set® applied on *Anticarsia gemmatalis* caterpillars (Lepidoptera: Noctuidae), whose mortality rate ranged between 0.8 and 3.2% (SILVA et al., 2012),

Although, when the products were sprayed on the silkworm integument, the product Planta Clean® caused 63.3% mortality, while the other treatments were statistically similar to the control (Table 2).

Planta Clean® sprayed on cassava leaves containing cochineal nymphs (*Phenacoccus manihoti*) (Hemiptera: Pseudococcidae) caused 57% mortality. However, Planta Clean® was hardly active against *A. gemmatalis* caterpillars (Lepidoptera: Noctuidae), causing only 1.3% mortality when applied at the recommended concentration on the artificial diet of caterpillars (RHEINHEIMER, 2010; SILVA, 2010).

The action of the insecticide Planta Clean® could be attributed to the presence of plant extracts in its composition (MATTIELO [s.d.]; SILVA, 2010; MAMPRIM et al., 2013).

The low mortality caused by Biogermex® and Agro-mos® was also observed on *A. gemmatalis* larvae: 5.6 and 3.2% with Agro-mos® and Biogermex®, respectively (SILVA et al., 2012). These results confirm that the product is safe for using in silkworms.

Considering that Planta Clean® proved to be lethal when applied to the integument of the caterpillars and harmless when ingested, and Soil-Set® caused high mortality only when applied on mulberry leaves, the difference in results is likely to be due to morphophysiological mechanisms that ensure certain resistance to toxic compounds.

The first mechanism is the integument itself, which is a mechanical, chemical and biological barrier. The polysaccharides present in the cuticle of insects are lipophilic, while many products are not. It is known that lipophilicity is inversely proportional to product solubility in water; therefore, the more lipophilic the compounds are, given the chemical similarity to the cuticle, the more they penetrate the insect's body at higher rates (GUSMÃO et al., 2000; GALLO et al., 2002).

Given the above, it can be inferred that Soil-Set® did not cause high mortality when applied on the integument, probably because of its low lipophilicity. On the other hand, Planta Clean® has fatty acids in its formulation, which can give the product a lipophilic character, thus facilitating its entry through the integument.

Even if product entry has occurred, however, it is known that insecticide molecules can be eliminated through detoxification. Through this mechanism, insects can modify the insecticide molecule at a rate that prevents its action on the target site by using enzymes from their bodies. Thus, toxic products turn into non-toxic fractions, which can be accumulated in inert forms inside the insect or be readily eliminated from the insect's body (CHAPMAN, 1998).

Soil-Set® showed reverse effect, with high mortality, when ingested. Nevertheless, this may be explained by the product formulation, which is a heavy metal-based biofertilizer whose action is by ingestion, according to MAIRESE (2005).

The high mortality of *B. mori* silkworms in the treatments with Soil-Set® applied on mulberry leaves, and Planta Clean® applied on silkworms, was reflected in the production of cocoons, which was significantly reduced when compared to other groups and also with the control (Table 2).

The treatments with Biogermex® applied on mulberry leaves, and Agro-Mos® applied on silkworms, showed a significant decrease of 13.3% in the number of cocoons in comparison

Table 2. Mortality cocoon production, cocoon unit weight, cocoon shell unit weight (g) and liquid silk percentage of *B. mori* silkworms subjected to treatment with alternative phytosatiny products daily sprayed on mulberry leaves, and on the silkworms for five days ($26 \pm 1^\circ\text{C}$, 12 hour photoperiod and relative humidity of 70%).

Treatment	Mortality (%)		Cocoons Formed (%)		Cocoon Unit Weight (g)		Cocoon Shell Unit Weight(g)		Liquid Silk Percentage (%)	
	Mulberry leaves	Silkworm	Mulberry leaves	Silkworm	Mulberry leaves	Silkworm	Mulberry leaves	Silkworm	Mulberry leaves	Silkworm
Planta Clean®	5.0 ± 3.2	63.3 ± 1.9*	93.3 ± 3.9	35.0 ± 1.7*	1.5 ± 0.03	-	0.26 ± 0.02*	-	13.2 ± 1.1*	-
Biogermex®	6.7 ± 2.7	8.3 ± 4.2	86.7 ± 2.7*	91.7 ± 4.2	1.5 ± 0.05	1.6 ± 0.03	0.27 ± 0.02*	0.34 ± 0.03	13.7 ± 1.1	16.2 ± 1.9
Soil-Set®	30.0 ± 4.3*	5.0 ± 3.2	18.3 ± 3.2*	93.3 ± 2.7	-	1.5 ± 0.03	-	0.27 ± 0.06*	-	13.8 ± 0.5
Agro-Mos®	8.3 ± 3.2	8.3 ± 3.2	90.0 ± 3.3	86.6 ± 6.1*	1.6 ± 0.08	1.5 ± 0.09	0.32 ± 0.01	0.30 ± 0.02	16.1 ± 1.4	15.6 ± 1.6
Control	0 ± 0		100 ± 0		1.54 ± 0.03		0.35 ± 0.01		17.28 ± 0.79	

*The data differ statistically from the mean value of the control by Dunnett's test ($p < 0.05$); -: Missing plot.

with the control. Although mortality was reduced and there was a lack of visible signs of intoxication, some silkworms in the treatment did not encapsulate (Table 2).

However, losses of up to 15% on sericulture are acceptable, and they occur as a result of low egg-hatching rates, inappropriate shed conditions (temperature, humidity, quality and quantity of offered leaves), etc. (HANADA; WATANABE, 1986).

In sericulture, the silk produced by silkworms is the final product, and the factors associated with their production should be analyzed. In this regard, factors related to insect biology such as survival, growth rate, larval stage duration and longevity are affected by the amount and quality of food ingested by the larvae (PARRA, 1991), and, consequently, it also reflects the quantitative and qualitative production of cocoons.

As for the cocoon unit weight, the values in both applications preventive and curative (mulberry leaves and silkworms) were statistically similar to the value of the control (1.5 g) (Table 2). Similar values (1.54 to 1.64 g) were found in comparative studies of mulberry cultivars for *B. mori* silkworms (PORTO et al., 2003).

However, because of high mortality, there were no cocoons that could be analyzed in the treatment for silkworms with Soil-Set® applied on leaves nor Planta Clean® applied on the silkworms (Table 2).

As for the cocoon shell unit weight, the means ranged from 0.26 to 0.34 g (Table 2). These data are similar to those found by PORTO et al. (2005), who studied the effect of the extract of *Mirabilis jalapa*, and found values ranging from 0.36 to 0.38 g.

The treatments with Planta Clean® and Biogermex® applied on mulberry leaves and Soil-Set® applied on silkworm differed from the control; they showed a reduction in the cocoon shell weight (Table 2). To some extent, this decrease can be attributed to the products, which affected the development of the caterpillars and the quality of the produced cocoons (HANADA; WATANABE, 1986).

Similarly, PORTO; OKAMOTO (2000) evaluated the effect of a disinfectant on *B. mori* silkworms, and during the experiment, there were no signs of intoxication; however, the cocoons of the treatments with higher concentrations of the product showed lower cocoonshell weight. Also, OLIVEIRA et al. (2010) observed a reduction in the number of cocoons produced by silkworms fed on mulberry leaves sprayed with alcoholic propolis extract. According to the latter authors, the accumulative action of the products may have caused some intoxication at the end of the cycle, even without visible signs during the experiment.

Regardless of the form of application, the liquid silk percentage produced by caterpillars was similar to the value of the control, with the exception of the Planta Clean® treatment applied on leaves, which resulted in 13.2% (Table 2).

These values were lower than those ones found by MUNHOZ et al. (2009), in whose study there was an oscillation between 17.4 and 18.7% of liquid silk produced by *B. mori* silkworms fed on mulberry leaves of plants that had received organic and chemical fertilizers. OLIVEIRA et al.

(2010) also observed between 16.5 and 17.28% of liquid silk produced by silkworms treated with leaves containing alcoholic propolis extract. Differences can be due to *B. mori* races, mulberry varieties, time of year etc., which affect the results.

Thus, the products Biogermex® and Agro-Mos® in both application (preventive application on mulberry leaves and curative application on the integument of the silkworms), Planta Clean® used only as a prevention, and Soil-Set® used only as curative method were selected for the next step. The other treatments, in comparison, do not have potential for use in silkworm management, once they cause damage to silkworms.

Effect of alternative phytosanitary products on prevention/control of white muscardine in *B. mori* silkworms

In the preventive treatment of the disease, with one application after fungal infection, there was no statistical difference in the treatment with the fungus alone. Although, in the silkworm group treated with four applications, mortality ranged from 16.7% in the treatment with Planta Clean® to 46.7% in the treatment with Agro-Mos®, which did not differ from the treatment with the fungus alone (Table 3). Regarding confirmed mortality, there was no difference between treatments compared with the treatment with the fungus (Table 3). In the control group, there was no mortality.

A similar study showed that by spraying fungicides (Benomyl, Maneb, Daconil, Maneb + Daconil, Cerconil and Neantina) on mulberry leaves containing conidia of *B. bassiana*, mortality was reduced between 24.4 and 36.7%. This result showed the effectiveness of fungicides in this form of application (CORSO; MOSCARDI, 1981).

With regard to the production of cocoons, there was no preventive action with one application; however, with four applications of the products, there was a higher production only with Planta Clean®, when compared to the treatment with fungus alone (Table 3).

When the products were applied as a curative strategy, only the treatment with the product Biogermex® showed values statistically different from the ones for treatment with fungus alone, with 26.7% reduction in mortality in the group treated with just one application of the product and 25% when treated with four applications (Table 3).

These corroborate CHAVAN et al. (2011), who also observed mortality reduction by the fungus *B. bassiana* between 21.6 and 28.3%, when plant extracts of *Argemone mexicana*, *Terminalia arjuna*, *Syzygium cumini* and *Annona squamosa* were applied on silkworms infected with the fungus. As for confirmed mortality, there was no difference when compared to the treatment with the fungus alone (Table 3).

By contrast, it was observed that when the products were applied only once, there was a significant increase in the number

Table 3. Total and confirmed mortality, and production of cocoons of *B. mori* silkworms infected with the fungus *B. bassiana* and treated with one and four applications of alternative phytosanitary products sprayed on mulberry leaves and on silkworms ($26 \pm 1^\circ\text{C}$, 12 h photophase and relative humidity of 70%).

Treatment	Total mortality%				Confirmed mortality %				Production of Cocoons %			
	Preventive		Curative		Preventive		Curative		Preventive		Curative	
	1x	4x	1x	4x	1x	4x	1x	4x	1x	4x	1x	4x
Planta Clean®	38.3 ± 6.3	16.7 ± 5.8	-	-	38.3 ± 6.3	15.0 ± 6.9	-	-	61.7 ± 5.7	83.3 ± 5.8*	-	-
Biogermex®	38.3 ± 9.9	31.7 ± 3.2	70.0 ± 6.9*	71.7 ± 3.2*	33.3 ± 9.4	30.0 ± 3.3	70 ± 8.6	71.7 ± 6.1	61.7 ± 9.9	68.3 ± 3.2	30.0 ± 6.9*	28.3 ± 3.2*
Soil-Set®	-	-	88.3 ± 3.2	81.7 ± 3.2	-	-	80.0 ± 8.6	75.0 ± 3.2	-	-	11.7 ± 11.7*	18.3 ± 3.2*
Agro-Mos®	38.3 ± 5.7	46.7 ± 8.6	85.0 ± 3.2	91.7 ± 5.0	38.3 ± 6.9	36.7 ± 4.3	85 ± 3.2	80.0 ± 10.5	61.7 ± 5.7	53.3 ± 8.6	15.0 ± 3.2*	8.3 ± 5.0
<i>B. bassiana</i>	38.3 ± 4.2	38.3 ± 4.2	96.7 ± 1.9	96.7 ± 1.9	36.7 ± 4.30	36.7 ± 4.30	75 ± 4.19	75 ± 4.19	61.7 ± 4.19	61.7 ± 4.19	3.3 ± 1.92	3.3 ± 1.92

1x: one application; 4x: four applications; *the data differ statistically from the mean value of the control (*B. bassiana*) by Dunnett's test ($p < 0.05$); -: missing plot.

of produced cocoons in all treatments when compared to the treatment with the fungus alone (26.7% in the treatment with Biogermex®, 11.7% in treatment with Agro-mos® and 8.4% in the treatment with Soil-Set®). When applied for four days, the products Biogermex® and Soil-Set® also promoted an increase when compared to the treatment with fungus alone (25 and 15%, respectively) (Table 3).

Biogermex® was the one who showed activity against the fungus *B. bassiana*, reducing the mortality of the silkworms in the curative strategy (Table 3).

Biogermex® is composed of bioflavonoids, i.e., molecules derived from the secondary metabolism of plants, which can act as antimicrobials. These molecules have the ability to bind to extracellular proteins of the cell walls of bacteria and fungi, inactivating them and also possibly disrupting their membranes

(TSUCHIYA et al., 1996). This is proven by the reduction of viability and decrease of colony forming units (CFU) of the fungus *B. bassiana*, as demonstrated by MAMPRIM et al. (2014).

A follow-up study to the present research is recommended, with reapplication tests or doses targeted at curative action.

CONCLUSION

Based on the results reported, it was concluded that the products Planta Clean®, Soil-Set® and Agro-mos® do not have effects on the development of white muscardine in *B. mori*. However, Biogermex® can be promising. New tests need to be conducted, focusing on the use of this product as a curative strategy.

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