



Quick Guide to Pest Control with

B-VAP

Instructions for the Steam Treatment of Bed Bugs



With the contribution of:

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Introduction

1.1 General Information



Bed bugs (*Cimex lectularius*) are a major problem for people. These small parasites, known for hiding in the most inconspicuous cracks and crevices and for being resistant to insecticides, feed on blood like other hematophagous insects (mosquitoes, sand flies, horseflies, gadflies, fleas, etc.).

Their bites are generally painless, allowing the insects to feed undisturbed. However, the bites cause itching, skin irritation, and in some cases allergic reactions.

A bed bug infestation can cause the affected person significant psychological and physical distress.

It is therefore crucial to have precise knowledge of these insects' biological characteristics and behavior, and to apply appropriate control and prevention strategies in order to effectively combat an infestation.

Nowadays, bed bugs are no longer just a problem in hotels, bed & breakfasts, or private homes — they are also found in public transportation, train stations, and airports. These insects have indeed also been found on seats in buses, trains, and airplanes.

At the European level, national institutions in countries such as France, Germany, and England declared a national state of emergency in 2023, while Italy has recently seen a marked increase in infestation numbers.

This technical manual is intended to provide detailed and practical information about bed bugs, in order to support professionals in combating and eradicating this pest.

1.2 Know Your Enemy: Bed Bugs

Significance for Health

Bed bug bites cause erythema and allergic reactions that, while painless, produce an irritating itch that can lead to secondary infections and cause sleep disturbances, anxiety, and psychological stress. Although they do not transmit diseases, their impact on quality of life and the costs associated with pest control are considerable, making effective pest management essential.

Biological Characteristics of Bed Bugs

Bed bugs are nocturnal pests with an oval, flattened shape; adults are about 4-5 mm long and reddish-brown in color. They feed exclusively on human blood and darken in color after feeding on the host's blood.

Their life cycle comprises three developmental stages: egg, nymph, and adult. The nymph develops from one molt to the next by feeding on blood until it becomes an adult. Mature eggs hatch after being laid, within 10 days (at 20 °C) or 4-5 days (at 35 °C), depending on temperature. The entire cycle from egg to adult takes, on average, about one month under ideal conditions of 20 °C.

Behavior and Feeding Habits

Bed bugs are attracted by body heat and the carbon dioxide produced by human breathing. They feed every five to ten days but can also survive for months without food. A meal generally lasts between 3 and 10 minutes. During this time, the insect attaches itself to the host's skin and feeds until fully engorged.

During the day, these pests hide in cracks and crevices near sleeping areas, such as in mattresses and bed frames, since they are light-sensitive. They are also frequently found in electrical outlets, baseboards, wardrobes, behind pictures, or behind curtains.

1.3 How to Recognize a Bed Bug Infestation

Recognizing a bed bug infestation requires a great deal of attention and patience.

To carry out a thorough inspection, certain essential tools are needed to detect bed bugs early:

- Flashlight
- Magnifying glass
- Screwdriver
- Insect collection container (such as a screw-top jar from a pharmacy)
- Brush or tweezers for collecting insects

⚠ Caution: *After a report from the occupant, it is important to inspect the environment as quickly as possible in order to promptly take the necessary measures to eliminate the bed bugs.*

The following aspects should be considered when searching for bed bugs:

1. **Bite marks on the skin:** If the occupant wakes up with bite marks on the skin, often arranged in lines or clusters, this could be a sign of bed bugs. These bites can itch and typically occur on arms, legs, the neck, or other body parts exposed during sleep.
2. **Blood or fecal traces:** After feeding, bed bugs can leave blood traces on sheets or pajamas — a sign of infestation. In this context, it is important to closely examine the seams of mattresses or pillows. It is also possible to find dark-colored droppings (0.3 mm to 1 mm in diameter) in furniture drawers next to beds, in wardrobes, or in suitcases.
3. **Unpleasant odor:** In the bedroom or near the bed and/or sofa, an "unpleasant" odor may be noticeable; this can be an indication of an infestation. However, the odor alone is not proof that bed bugs are actually present.
4. **Direct sighting of bed bugs:** Young or adult bed bugs are likely visible to the naked eye on the mattress, bed, or surrounding furniture (and may have been photographed). Nevertheless, it is necessary for pest control personnel to be on site to assess and determine the extent of the infestation.

2.1 Advantages of Using Steam

Immediate effectiveness

High-temperature steam quickly kills adult bed bugs as well as eggs and nymphs. High temperatures penetrate the cracks and folds of mattresses, where bed bugs like to hide.

Crevice penetration

Steam is able to penetrate cracks and hidden spots where bed bugs frequently take refuge, reaching areas that would otherwise be difficult to treat with insecticide sprays or powders.

No neurotoxic insecticides

Eliminating pests with steam requires no insecticides or other chemicals, which is particularly beneficial in "sensitive" environments such as bedrooms, hospitals, and schools, where exposure to chemicals could be hazardous.

Reduced insecticide resistance (no resistance)

Bed bugs can develop resistance to insecticides over time, making chemical treatments less effective. Steam, by contrast, uses physical heat generated by high temperature — bed bugs do not develop resistance to this.

Safety for human and pet health

Steam is safe for humans and pets. It leaves no toxic residues in the environment and poses no risk to human health.

Versatility and accessibility

Steam generators are versatile devices that can be used on a wide variety of surfaces and materials, including mattresses, furniture, upholstery, carpets, and curtains.

Removal of hidden dirt

Steam eliminates not only bed bugs but also hidden dirt and allergens, improving the overall cleanliness of the room.

Environmental sustainability

The use of steam makes it possible to combat these pests with an environmentally friendly and sustainable method that reduces or entirely eliminates the need for harmful chemicals.

Why Steam?

2.2 Advantages of Using B-VAP

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- The steam gun is equipped with an internal 400 W heating element, which allows the outgoing steam to be heated to 130 °C.
- The accessory's special connector muffles the steam flow, so that bed bugs are not scattered around the room.
- Equipped with a steam hose and connector for attachment.
- High-temperature steam is lethal to bed bugs and their eggs.
- Unlike chemical pesticides, steam is a completely environmentally friendly cleaning method that releases no harmful residues into the environment.
- The gun can be used on all surfaces.
- Monitoring the environment and regular use of steam can prevent a renewed infestation.



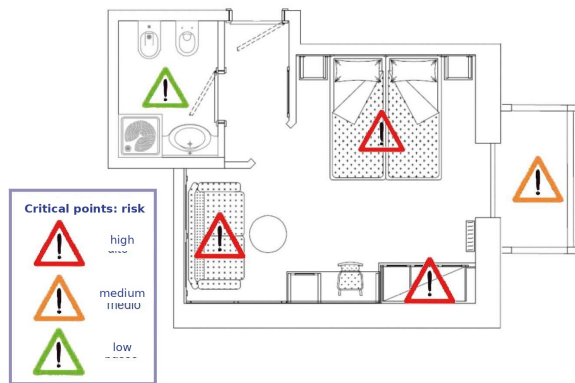
Preparation for Steam Treatment

3.1 Preparing the Area to be Treated

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To adequately combat bed bugs, certain steps must be followed to ensure the effectiveness of the pest control treatment. First, inform the customer that they should avoid moving anything, if possible, until the technician arrives. Then:

- Remove bed linens (sheets, blankets, pillowcases) and wash them in the washing machine at a minimum of 60 °C.
- Carefully inspect the mattress and the bed frame. If possible, disassemble the bed to inspect the individual components.
- Remove clothing and other textiles: Remove all clothing items, cushions, curtains, and other textiles in the room. Also wash these items at high temperatures and dry them properly.
- Tidy up: Reduce clutter in the room and in furniture and closets to make it easier for the operator to access all affected areas.
- Clean the environment: Use a vacuum cleaner with a HEPA filter to remove dust and other debris from the room and to vacuum up bed bugs and their eggs.
- Dispose of waste: Immediately empty the vacuum cleaner container into a sealed plastic bag, then treat the surface with steam to eliminate any live insects or other organisms.



Preparation for Steam Treatment

3.2 Preparing the Steam Generator with B-VAP

1. Fill water into the tank or boiler — depending on which model you purchased.
2. Plug the generator's power cord into the outlet.
3. Insert the B-VAP accessory's plug into the socket of your dry steam cleaner and make sure that the plug's black spring clip is properly locked into the socket.



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**For the B-VAP version with an external power cable:**

- Plug the B-VAP's power cord into the outlet.

4. Switch on the main switch at the back of the unit, press the power button and the boiler button, and wait about 5-6 minutes until the green "steam ready" light on the device lights up. At that point, both the steam generator and the B-VAP gun are ready for use.
5. Once the accessory is correctly attached, the heating element inside the gun begins to heat up.

⚠ Caution: *The first time the trigger is pressed, smoke may come out of the gun. This is due to moisture that has accumulated during storage; this phenomenon disappears after a few minutes. When switching on the device for the first time, or if it has not been used for an extended period, you should discharge the first burst of steam onto the floor to clear the pipe of processing residue and contaminants.*

6. To activate the steam, press one of the two buttons on the accessory's handle. Both buttons are set to the same steam output (minimum steam volume).



⚠ **Caution:** Before steaming surfaces, let the condensate produced by the device drain into a container for about one minute.

7. The surface treatment can now begin, working at a distance of about 20 centimeters and moving the gun slowly.



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3.3 Tips for a Complete and Effective Treatment

To ensure a comprehensive and effective treatment against bed bugs, it is important to keep a few key tips in mind:

- Examine all suspicious areas, including beds, furniture, carpets, pictures, curtains, electrical outlets, baseboards, or cracks in floors or walls.
- Check beds for bed bugs or signs of their spread (dark spots on textiles).
- Move the steam slowly over all affected surfaces so the heat can penetrate and kill the bed bugs and their eggs.
- If the bed bug infestation is particularly severe, further inspections and additional steam treatments are necessary.
- After the initial treatment, it is recommended to schedule at least one follow-up inspection within 7-10 days.
- All signs of infestation (blood stains, droppings, adult insects, and nymphs) must be removed to avoid confusion during future inspections.
- After treatment, it is advisable to ventilate the room to ensure the treated areas dry completely.

Conclusions

4.1 Post-Treatment Monitoring and Preventive Measures

Cleanliness:

Keep rooms and areas with potential pest infestation clean and tidy to reduce insect hiding places.

Monitoring with traps:

After the steam treatment, passive monitoring devices can be placed at key locations. The number of devices depends on both the size of the site and the type of infestation. Various models of monitoring traps specifically designed for bed bugs are available on the market.

Training:

In hospitality businesses, it is essential to train staff on proper room cleaning and tidying, especially bed-making. In this context, it is important that staff know where the monitoring devices are located, so they can immediately report any signs of bed bugs to the technicians responsible for steam pest control.

Sealing:

Seal all cracks and gaps in walls, floors, and furniture to prevent bed bugs from finding new potential hiding places.

4.2 Evaluating Treatment Success

The success of the treatment can only be assessed 7–10 days after the pest control treatment. After that, regular checks must be carried out to ensure the parasites have been eliminated.

⚠ Caution: *Since bed bug eggs hatch at room temperature within 7–10 days, it is advisable to wait at least this period of time between the end of the treatment and the follow-up inspection.*

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Source of photographic documentation: Institute for Animal Disease Control of the Veneto Region (IZSve)

Appendices

5.1 Biology of Bed Bugs

The bed bug (*Cimex lectularius*) is the best-known insect from the family Heteroptera Hemiptera. It is a dark, brick-red, rust-colored insect that can reach a total length of 6 to 8 mm (females are larger than males).

When fasting, the bed bug's body is oval and strongly flattened. After a blood meal (fully engorged adult), its shape becomes more elongated. Its head is short and broad, with small but very prominent compound eyes, four-segmented antennae, and a fairly short proboscis that is almost invisible at rest, lying within a groove.

The thorax is rather small, and the wings — reduced to small oval scales — are attached to it, leaving the broad, almost round abdomen completely exposed. The legs are medium-length and equipped with three-segmented tarsi.



Female of *Cimex lectularius*



Male of *Cimex lectularius*

To complete their life cycle, bed bugs require fairly high temperatures and therefore settle in rooms that are heated in winter and in the warmest spots in a house. However, they can also withstand low temperatures. In such cases, they remain inactive until the environment becomes thermally suitable again. They feed at night, typically for 3-10 minutes, and are light-sensitive. After about a week, they take another blood meal.

They can fast for months — even over a year — while retaining nearly all of their vigor. When living in an environment where the temperature varies little throughout the year, they can reproduce at any time and produce three generations within twelve months.

Bed bugs lay pearl-gray eggs in clusters, usually in the same spaces where they rest; the eggs are just over 1 mm long and half a millimeter wide, ellipsoidal, with a small operculum at the front end. In total, each female lays between 200 and nearly 300 eggs.

The incubation period and the duration of the pre-adult (juvenile) stages depend mainly on environmental conditions, food availability, and above all on thermal conditions.

At an average temperature of about 25 °C, eggs hatch after 8 days. However, it takes 11 weeks for the newly hatched nymphs to reach the final stage after 5 molts. In addition, larvae must take in a certain amount of blood at each life stage. If the insects are not fed, or are fed insufficiently, the nymphal period is greatly extended. Even larvae can survive very long fasting periods without harm.

Under optimal environmental and feeding conditions, bed bugs need only 7 weeks to progress from the first stage to the adult (imago) stage. Cold slows their development, but excessively high temperatures are also unfavorable.

If a temperature of 50 °C is maintained in their environment for a few days, for example, all young and adult bed bugs die.

When bed bugs have abundant access to food, they can multiply at an alarmingly fast rate (over 1,000 individuals within 90 days).

Significance for Health (Reports of the Italian National Institute of Health, ISTISAN 12/41)

Although bed bugs are considered potential disease vectors, they do not transmit pathogens to humans.

Bed bug bites do, however, cause itchy local edema and erythema, largely due to allergic reactions resulting from the injection of an anticoagulant contained in the insect's saliva.

The reaction varies from person to person: while some develop significant local inflammation, others experience no inflammation at all.

Scratching can lead to bacterial secondary infections in the edematous area. A severe infestation can cause nervous system and digestive disorders in hypersensitive individuals.

It has also been reported that children living in heavily infested homes can suffer from severe forms of asthenia, which are not always attributable solely to malnutrition.

5.2 Inspection Overview

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Date	Location
Operator	Room No.

	YES	NO	NOTES
Sheets and pillowcases			
Mattress – head area			
Mattress – foot area			
General mattress area			
Bed frame structure			
Bed legs			
Box spring / slats			
Lockers			
Wardrobe			
Baseboards			
Electrical outlets			
Pictures			
Chairs			
Armchairs			
Etc.			

**Other insects / characteristic odor / fecal stains / etc.*

5.3 Procedure for Reporting Bed Bugs in Rooms

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- **DATE:** __ / __ / __
- **PERSON RESPONSIBLE FOR MONITORING ROOM NO.:** __
- **NUMBER OF AFFECTED ROOMS:** __
- **NAME OF COMPLAINING GUEST:** __
- **GUEST'S ORIGIN:** __
- **PREVIOUS GUEST'S ORIGIN:** __

Step-by-Step Instructions

1. Lock the room and allow access only to inspection personnel.
2. Proceed as specified in the "Inspection Overview."
3. Collect any insect specimens in vials to show to the pest control company.
4. Call the responsible pest control company.

After Treatment

1. Do not enter the room until the pest control company has declared it accessible.
2. Carry out thorough cleaning to remove any residues from room surfaces.

5.4 B-VAP Certification

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EFFICACY ASSESSMENT OF "B-VAP"
AGAINST *Cimex lectularius*

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EFFICACY ASSESSMENT OF "B-VAP"
AGAINST *Cimex lectularius*

Test completed on
11 June 2024

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Report code: Q016A-24-Q042A-24				

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1. TEST DATA SHEET

Study conducted for:	THERMOSTAR HANDELS-GMBH, Auen-Süduferstraße 67, 9220 Velden, Austria
Study conducted by:	Entostudio S.r.l., Viale del Lavoro 66 – 35020 Ponte San Nicolò (PD), Italy
Study conducted at:	Entostudio S.r.l., Viale del Lavoro 66 – 35020 Ponte San Nicolò (PD), Italy
Study coordinator:	Entostudio S.r.l., Viale del Lavoro 66 – 35020 Ponte San Nicolò (PD), Italy
Study supervisor:	Dr. Andrea Drago
Person responsible for the study:	Matteo Cecconello
System tested:	B-VAP
Species used for the test:	<i>Cimex lectularius</i>
Test start date:	20 May 2024
Test completion date:	11 June 2024

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2. TEST OBJECTIVE

To assess the effectiveness of the "B-VAP" steam system against the target species through a simulated field-use test.

3. SUMMARY

Target insect: *Cimex lectularius*

Formulation of the tested machine: The machine used for the test is a steam generator with a superheater gun. The machine used for the test was a steam generator supplied by the sponsor. Distilled water was used for the treatment.

Test methodology: A harborage was created by stacking two surfaces on top of each other to form a small gap. The harborage was then placed in a plastic arena, in which 5 insects (of different developmental stages and both sexes) were placed inside the gap. After an acclimatization period, treatment was carried out by applying steam around the harborage. Knockdown time and 24-hour mortality were then assessed.

The same procedure was carried out with 10 eggs placed in the harborage, which were observed for 1 week following treatment.

4. MATERIALS AND METHODS

4.1 INSECT SPECIES USED AND REARING CONDITIONS

The bed bugs used for the test were reared in Entostudio's laboratory.

The bed bugs are kept in the laboratory at 27 °C and 75% relative humidity. The photoperiod is 12 hours. They are contained in tubes with a piece of black cardboard and sealed with a tulle net. Once a week, the container is placed tulle-side down on a Parafilm bag filled with defibrinated rabbit blood, allowing the bugs to feed. Females lay their eggs on the cardboard. The colony was established in 2022 from bed bugs sourced from the Czech University of Life Sciences in Prague (CZU).

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4.2 DETAILS OF THE TESTED MACHINE

Name: EVO

Description of the tested machine: The test was carried out using the "B-VAP" superheater gun connected to the sponsor's steam generator (boiler output 0.8 kW/h, steam production 1.3 kg/h at 152 °C – 4 bar).

The Thermostar models Avantgarde, Avantgarde Plus, Superb, Professional, Professional Plus, Industrial, Medicleantec, Medicleantec Trolley, and Medicleantec II are, according to the sponsor, equivalent to or better than the tested model in terms of flow rate and pressure.

4.3 DOSAGE APPLIED

Each harborage was treated for 4 seconds, with the steam applied from a distance of 20 cm.

4.4 TEST ROOM SPECIFICATIONS

The room in which the tests were conducted has a rectangular floor plan measuring 3.15 x 2.90 x 3.03 (H) m, corresponding to an area of 9.14 m² and a volume of 27.7 m³. The room is entirely white and washable. Environmental parameters (temperature and humidity) are automatically monitored and controlled, as is the lighting, which is provided by artificial light with a solar spectrum (4,000 K).

During the test, the temperature is maintained at 27 ± 1 °C, relative humidity at 50 ± 5%, and light intensity at 300 lux. At the end of each replicate, the air in the room is replaced by an extraction system capable of extracting 2,800 m³/h.

4.5 INSTRUMENTATION USED

The following devices, with the specifications listed below, were used during the test:

- CompactSteam humidifier (CAREL S.p.A.)
- TFA digital thermo-hygrometer, for measuring environmental parameters

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- Nimex Ni 2600 digital lux meter, for measuring light intensity
- Daikin FDXM25F2V1B (indoor unit) and Daikin RXM25M (outdoor unit), for air conditioning/temperature
- BITICINO H4684-AM5864, for photoperiod management
- SAMLA arena, 78 x 56 x 18 cm (volume 56 L)
- ZEISS Stemi 508 stereomicroscope
- Steam generator

4.6 DEFINITION OF TEST AND REPLICATE

Test: the complete procedure for evaluating a product, consisting of the entirety of the replicates carried out.

Replicate: corresponds to one treated arena and one control arena. The procedure begins with the introduction of insects into the container.

4.7 ASSESSMENT PARAMETERS: DEAD, MORIBUND, AND ALIVE

Dead: insects showing no signs of life are considered dead.

Moribund: insects that, at the end of steam exposure, display behavioral changes, trembling, difficulty moving, or inability to walk are considered moribund.

Alive: insects showing no behavioral changes.

4.8 EXPERIMENTAL PROCEDURE

The test was carried out in a plastic arena measuring 78 x 56 x 18 (h) cm, with a base area of 0.43 cm² and a volume of 56 L.

Each arena corresponds to one replicate.

A harborage was set up in the center of the arena (Figure 2). The harborage was created by stacking two non-porous surfaces (ceramic tiles, glazed side) and two porous surfaces (wood tiles) on top of each other to create a gap of about 4 mm.

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For each surface type, 3 treated replicates and 3 control replicates were carried out.

For each replicate, 5 insects (of both sexes and different developmental stages) were used.

The insects were introduced 15 minutes before treatment; during this acclimatization phase, the light was left on to encourage the insects to remain in the gap.

Before applying steam, the equipment used was prepared according to the following instructions:

- Distilled water is filled into the tank
- The superheater gun is connected to the device's steam outlet
- The boiler is then switched on for approximately 5 minutes, the time needed to reach the required operating pressure (165 °C – 6 bar)
- The steam condensate was released into a container for about 1 minute to standardize the device's pressure before application

Once the device's minimum output was set, steam was applied around the harborage for 4 seconds, maintaining a distance of 20 cm.

After the application was completed, the harborage was opened and the knockdown time was assessed (Figure 3). The killed insects were then placed in a plastic container, where mortality was recorded after 24 hours.

The same procedure was carried out on harborages made with non-porous surfaces, using 10 eggs for each replicate. After the product was applied, the eggs were placed in a plastic container and observed for one week to determine whether or not they hatched.

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Fig. 2. Harborage used for the test



Fig. 3. Bed bugs treated with steam

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5. RESULTS

5.1 ADULTS AND LARVAE

The results obtained are shown below.

Table 1: Results for the wood surface

20 May 2024 Time (min)	Treated (No. affected)			Average (%) ± SEM	Control (No. affected)			Average (%) ± SEM
	T.1	T.2	T.3		C.1	C.2	C.3	
2	5	5	5	100.00±0.00	0	0	0	0.00±0.00
5	5	5	5	100.00±0.00	0	0	0	0.00±0.00
Alive 24h	0	0	0	0.00±0.00	5	5	5	100.00±0.00
Moribund 24h	0	0	0	0.00±0.00	0	0	0	0.00±0.00
Dead 24h	5	5	5	100.00±0.00	0	0	0	0.00±0.00

Table 2: Results for the ceramic tile surface

20 May 2024 Time (min)	Treated (No. affected)			Average (%) ± SEM	Control (No. affected)			Average (%) ± SEM
	T.1	T.2	T.3		C.1	C.2	C.3	
2	5	5	5	100.00±0.00	0	0	0	0.00±0.00
5	5	5	5	100.00±0.00	0	0	0	0.00±0.00
Alive 24h	0	0	0	0.00±0.00	5	5	5	100.00±0.00
Moribund 24h	0	0	0	0.00±0.00	0	0	0	0.00±0.00
Dead 24h	5	5	5	100.00±0.00	0	0	0	0.00±0.00

5.2 EGGS

The results obtained are shown below.

Table 3: Results for *Cimex lectularius*

11 June 2024	Treated tiles (hatched eggs)			Average (%) ± SEM	Control (eggs affected)			Average (%) ± SEM
	T.1	T.2	T.3		C.1	C.2	C.3	
No. of eggs per replicate	10	10	10	100.00±0.00	10	10	10	100.00±0.00
Hatched, day 1	0	0	0	0.00±0.00	4	4	4	40.00±5.77
Not hatched, day 1	10	10	10	100.00±0.00	0	0	0	0.00±0.00
Hatched, day 2	0	0	0	0.00±0.00	7	7	8	66.67±6.67
Not hatched, day 2	10	10	10	100.00±0.00	0	0	0	0.00±0.00
Hatched, day 3	0	0	0	0.00±0.00	10	10	10	100.00±0.00
Not hatched, day 3	10	10	10	100.00±0.00	0	0	0	0.00±0.00
Hatched, day 4	0	0	0	0.00±0.00	10	10	10	100.00±0.00
Not hatched, day 4	10	10	10	100.00±0.00	0	0	0	0.00±0.00
Hatched, day 5	0	0	0	0.00±0.00	10	10	10	100.00±0.00
Not hatched, day 5	10	10	10	100.00±0.00	0	0	0	0.00±0.00
Hatched, day 6	0	0	0	0.00±0.00	10	10	10	100.00±0.00
Not hatched, day 6	10	10	10	100.00±0.00	0	0	0	0.00±0.00
Hatched, day 7	0	0	0	0.00±0.00	10	10	10	100.00±0.00
Not hatched, day 7	10	10	10	100.00±0.00	0	0	0	0.00±0.00

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6. CONCLUSIONS

Based on the tests carried out, the following was established:

Larvae and adults:

In the treated replicates, knockdown after 2 minutes was 100% for both surfaces tested, and mortality after 24 hours was 100%. No knockdown or mortality was recorded in the control replicates.

Eggs:

In the treated replicates, no egg completed hatching during the 7-day evaluation period.

In the control replicates (not treated with steam), by contrast, all eggs had hatched after 4 days of observation.

Ponte San Nicolò,
30 June 2024

Signature

Andrea Drago, PhD

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