

Draft standard(s) of thermal treatments for *Xylella fastidiosa* on deciduous evergreen perennial species

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1 BACKGROUND

This deliverable concerns the preparation of a draft for a Standard entitled "Hot water treatment of grapevine, fig, pecan and white mulberry to control *Xylella fastidiosa*". The draft Standard describes long-duration hot-water treatment (HWT) procedures against *Xylella fastidiosa* for plants for planting including grapevine (*Vitis* spp.), fig (*Ficus carica*), pecan (*Carya illinoinensis*) and white mulberry (*Morus alba*), including the technical requirements for applying the treatment. This HWT may also contribute to control some of *X. fastidiosa* vectors that can lay eggs on propagating material, as well as other pests, such as those covered by EPPO standard PM 10/18 '*Hot water treatment of grapevine to control grapevine Flavescence dorée phytoplasma*'. A shorter hot water treatment of grapevine against *Viteus vitifoliae* is described in EPPO standard PM 10/16 '*Hot water treatment of grapevine to control Viteus vitifoliae'*.

1.1 Status of the draft Standard and pending experimental confirmation

The present version should be considered a draft Standard under technical consolidation, as some experiments are still ongoing and their outcomes may require further refinement of the proposed treatment conditions. In particular, the following points remain to be confirmed:

- Repetition of the experiments assessing the tolerance of fig and white mulberry cuttings to HWT at 50°C x 45 min and 48°C x 45 min in selected cultivars. The previous results were considered unreliable because they showed higher mortality rate on whole plants than observed in previous results, likely due to unexpected technical problems affecting rooting under greenhouse conditions.
- Assessments, after six months of *in vivo X. fastidiosa*–infected material treated by HWT at 50°C × 45 min and 48°C × 60 min to confirm whether all samples remain negative.
- Assessment of ongoing additional HWT experiments at 48°C and 49°C × 30/45/60 min on *X. fastidiosa*–infected almond and grapevine material.
- Assessment of the ongoing experiments determining the time required for the target temperature to reach the centre of the canes when diameter exceeds 3 cm.

Relevant comments are indicated in the draft Standard in square brackets "[ ]". Elements requiring experimental confirmation are additionally highlighted in grey colour.

A revised version of the draft Standard will be discussed with the EPPO expert working group in July 2026, once the additional experimental results are available. Following publication of the BeXyl Project results in scientific journals, the technical dossier supporting this draft Standard will be updated accordingly. The draft Standard will then be reviewed by the EPPO Panel on Phytosanitary Measures before being submitted for country consultation.

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2 DRAFT STANDARD: HOT WATER TREATMENT OF GRAPEVINE, FIG, PECAN AND WHITE MULBERRY TO CONTROL *XYLELLA FASTIDIOSA*

2.1 Introduction

Xylella fastidiosa is the causal agent of several plant diseases affecting a wide range of cultivated, ornamental, and wild host plants. Among the most economically important diseases are olive quick decline syndrome, almond leaf scorch, citrus variegated chlorosis and Pierce's disease in grapevine (EFSA PLH Panel, 2019; EPPO, 2026). The bacterium also causes, within others, leaf scorch in mulberry (Hernandez-Martinez *et al*., 2006), fig (Kostka *et al*. 1986) and pecan (Melanson & Sanderlin, 2013). The pathogen is included in the EPPO A2 List of pests recommended for regulation as quarantine pests (EPPO, 2026).

Based on genomic analyses, *X. fastidiosa* is a genetically diverse species with three main recognized subspecies: *fastidiosa*, *multiplex,* and *pauca,* although additional subspecies have been proposed, *sandyi* and *morus* (Schaad *et al*. 2004; Denancé *et al*. 2019). The subspecies can be further classified below the subspecies level into sequence types (STs) through multilocus sequence typing (MLST) analysis based on seven housekeeping genes (Yuan *et al*. 2010).

The first official finding of *X. fastidiosa* in the EPPO region occurred in 2013 in Salento (Apulia, Italy), identified as subspecies *pauca* ST53. Subsequently, several outbreaks caused by subspecies *multiplex*, *pauca*, and *fastidiosa* have been detected in France, Israel, Portugal, Spain and Lebanon.

Natural short- and medium-distance dispersal occurs via xylem-feeding insect vectors; primarily spittlebugs of the Aphrophoridae family in Europe, such as *Philaenus spumarius, Philaenus italosignus* or *Neophilaenus campestris,* while in other continents several species of sharpshooters of Cicadellidae families are involved (EFSA, 2026)[1]. However, the principal risk of introduction into uninfected areas and long-distance dispersal is the trade and movement of infected plant propagation material, such as cuttings and rooted plants (EFSA PLH Panel, 2015). In addition, some of the *X. fastidiosa* insect vectors have been reported to lay eggs on woody plant materials used for propagation such as *Homalodisca vitripennis*, contributing to the risk of pathogen dissemination by propagating plant materials (Gould *et al*., 2004b).

The bacterium exclusively colonizes the xylem of host plants, obstructing the flow of water and nutrients. Consequently, in comparison with other pathogens limited to the external phloematic tissues, such as phytoplasmas (McCoy *et al*., 1989), an effective thermal treatment will require heat penetration across the entire diameter of the wood. Hot water treatment (HWT) is a robust and reliable technique widely used to inactivate pathogens in dormant propagation materials, without compromising the viability of nursery material (Waite & Morton, 2007; EPPO, 2009; EPPO, 2012). As *X. fastidiosa* has an extremely broad host range (more than 700 species) (EFSA, 2026), the efficacy of specific time/temperature combinations,

[1] EFSA Scientific Opinion on the control of insect vectors of *Xylella fastidiosa* (under preparation, endorsed in February 2026 and under country consultation)

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together with the capacity of host plants to tolerate thermotherapy while preserving plant vitality, may vary depending on the host plant species (Brans *et al*., 2026; Gramaje & Armengol, 2012). HWT has been already routinely used in grapevine (*Vitis* spp.) and is recommended in EPPO Standard PM 4/8 '*Pathogen-tested material of grapevine varieties and rootstocks*' (EPPO, 2008; under revision). In particular, it is used for the control of grapevine Flavescence dorée phytoplasma under the prescribed conditions of 50° for 45 minutes (EPPO standard PM 10/18; EPPO, 2012). For *Vitis* spp., the EFSA Panel on Plant Health (2015) proposed that the conditions already described for Flavescence dorée could be also effective for the elimination of *X. fastidiosa* and its subspecies from grapevine propagation material. Alternative schedules for *X. fastidiosa* on grapevine have been reported by Goheen (1973) and CDFA (2023), but are mentioned as exceptions when using specific premises.

Pending the publication of the numerous experiments conducted within the Horizon Europe BeXyl Project (Beyond *Xylella*, Integrated Management Strategies for Mitigating *Xylella fastidiosa* impact in Europe), only a limited number of scientific studies have investigated the use of this technique on *Ficus carica* (e.g., for fig mosaic disease; Çağlayan *et al*., 2009) and *Morus alba* (Tahama *et al*., 1968; Hu *et al*, 2014; Sharma & Sharma, 1987). Among host species of economic importance, those selected to be studied within the BeXyl Project were chosen according to their evergreen vs deciduous characteristics and their propagation methods (e.g., self-rooted plants and grafted material). The species tested included *Vitis* spp. (grapevine), *Olea europaea* (olive), *Prunus dulcis* (almond), *Prunus avium* (sweet cherry), *Prunus persicae* (peach), *Prunus armeniaca* (apricot), *Ficus carica* (fig), *Morus alba* (white mulberry), *Juglans regia* (walnut). Other species selected included forestry and other ornamental plants, such as *Acer campestre* (field maple), *Quercus* spp. (oak), *Laurus nobilis* (laurel), *Lavandula angustifolia* (lavender), *Nerium oleander* (oleander), *Ulmus minor* (field elm). Some of these species are reported in the literature to be sensitive to HWT and this has also been confirmed during BeXyl's project experiments. notably, stone fruits and olive (Brans *et al*., 2023; Branzanti *et al*., 1994; Fontanazza *et al*., 1996). Although preliminary results obtained for certain species (e.g., almond and walnut) are promising, these findings remain provisional and will require further research, as well as validation and possible adaptation of treatment protocols, before they can be subject to a formal HWT recommendation.

2.2 Commodities/regulated articles

Since propagation methods and uses vary across species in the genera *Carya*, *Ficus*, and *Morus*, this Standard focuses on the species *M. alba*, *F. carica*, and *C. illinoinensis* for which specific data is available. For *Vitis*, most rootstocks currently in use are interspecific hybrids. Although some variation in susceptibility to HWT has been reported (e.g., higher thermal susceptibility for some hybrids (FFPV & IFV, 2023); and for *Vitis vinifera* 'Riesling' and related crosses (Zink & Eder, 2015), the present Standard applies to all *Vitis* spp.

Vegetative propagated plant material represents the main documented pathway for long-distance spread of *X. fastidiosa*. Seed transmission is generally considered absent or epidemiologically negligible in most host species, although recent preliminary evidence has suggested possible seed-associated transmission in pecan (Cervantes *et al*., 2022; EPPO, 2022).

Although older material may be used for ornamental purposes, this Standard only applies to

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propagated material with less than two years of vegetative growth. The Standard does not cover seeds and green cuttings.

The following commodities are covered by the Standard:

- **Dormant woody cuttings of scions and rootstock, or bare-rooted plants of *Vitis* spp.**
  Grapevine is predominantly propagated by grafting scions onto rootstocks of American or interspecific origin, particularly in areas where resistance to soil-borne pests (e.g. phylloxera) is required. Self-rooted cuttings of European grapevine cultivars may also be produced and propagated for specific uses.
- **Dormant woody cuttings or bare-rooted plants of *Ficus carica.***
  At nursery level, fig is commonly propagated by self-rooted cuttings (Boliani *et al*., 2019).
- **Dormant woody cuttings of scions and rootstock or bare-rooted plants (grafted or non-grafted) of *Morus alba.***
  White mulberry is commonly propagated by grafting, especially for specific and ornamental cultivars (Ziaei Moghadam *et al*., 2019).
- **Dormant woody cuttings of scions or bare-rooted plants (grafted or non-grafted) of *Carya illinoinensis.***
  Pecan rootstocks are generally obtained from seed, and later grafted or budded with a superior pecan nut cultivar. Layering techniques are also used (Casales *et al*., 2018; Silva *et al*., 2023; Sparks, 2005).

The treatment described in this Standard could be considered effective for dormant woody cuttings and bare-rooted plants (less than 3 cm in diameter) from other host species, provided that host species are able to tolerate these conditions (See section 2.4. *Efficacy of treatment*).

2.3 Treatment conditions

HWT represents a significant stress and may result in the loss of treated material if not applied correctly. Therefore, appropriate precautions should be taken prior to, during and after the treatment, as described below. The recommended treatment schedule is summarized in Table 1.

Table 1. Treatment schedule

Pre-treatment		Hot water treatment		Post-treatment	
Time (h)	Air *T* (°C)	Time (min)	Water *T* (°C)	Time (h)	Air *T* (°C)
12-24	Room temperature (more than 12°C during the winter period)	45*	50	12-24	Room temperature (more than 12°C during the winter period)

*For the final plants for planting, in case the maximum diameter of the trunk exceeds 3 cm, preliminary experimental data suggest that a longer exposure time may be required to ensure temperature penetration in the wood. In those cases, it is recommended to extend the treatment duration to 50 min (Bexyl, unpublished data; EFSA PLH Panel, 2015 citing Burr *et al*., 1996).

[Alternative treatment schedules may be proposed depending on the outcomes of the latest experiments (e.g., 48°C x 60 min or 48°C x 45 min)]

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It is worth mentioning that some equipment for HWT includes two water baths: one for 'pre-heating' and a second for the HWT itself. A pre-heating phase (e.g., 30-35°C for 15-30 min), allows a more gradual increase of temperature in the plant limiting thermal stress, improving thermal uniformity within the plant material, and reducing the temperature drop when submerging plant material in the hot water treatment bath (Waite & Morton, 2007; EFSA PLH Panel, 2015). If pre-heating, the treatment should be done in addition to the pre-treatment at room temperature.

2.3.1 Pre-treatment

Plant material to be treated should contain the highest possible level of reserves and be fully lignified. Plants should have completed their vegetative cycle at the beginning of pruning or uprooting and should stay in full dormancy, a physiological stage occurring after, and not far from the full leaf fall (Pouget, 1963; Lang *et al*., 1987). Cuttings or rooted plants that are not fully dormant are very sensitive to hot water treatments and may not tolerate the treatment.

Woody material, i.e., scions and rootstocks prior to grafting or rooting, as well the grafted or rooted plants, should be preferably held in cold storage (1–5°C) under high relative humidity (e.g., over 90%) to avoid dehydration, maintain dormancy and preserve plant quality.

For medium and long cold storage periods (e.g., 1-6 months), it is advisable to prevent the development of cold tolerant (psychrotolerant) fungi such as *Collybia*, *Botrytis*, *Alternaria* and others by:

- treating the plant material through immersion in fungicide or sodium hypochlorite solutions;
- storing the plant material not wet to minimize condensation, avoiding temperature fluctuations and preventing water from dripping directly onto the material;
- performing an annual cleaning and sanitization of the cold storage room, e.g. using sodium hypochlorite or quaternary ammonium salts.

The plant material should be taken out of cold storage 12-24 h before treatment and maintained at room temperature in a humid and aerated chamber. To ensure an optimal and uniform temperature transmission in all xylem tissues, soaking the material in clean water at room temperature for at least 12 h is common practice (Figure 1A). No fungicide or hypochlorite should be added to the soaking water. Water should be changed regularly, and the equipment and water containers regularly cleaned and sanitized to limit the risk of spreading other pathogens.

The roots of the bare rooted plants should be washed prior to treatment to limit the risk of spreading pathogens, contaminating other clean materials (Figure 1B).

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Figure 1. A. Pre-soaking tank. B. Washing of bare rooted plants prior to treatment. Credit: Pierfederico La Notte (CNR-IPSP, IT)

2.3.2 Treatment

For propagation material such as cuttings, HWT should be done immediately before grafting or rooting, at the end of the storage period. For rooted plants, the treatment should be done as close as possible to the final planting stage. Treatment during medium- to long-term storage in a refrigerated chamber is strongly inadvisable.

When treating cuttings in bags/containers, packaging should allow good water circulation around the plants (see examples of good and bad practices in Figure 2, A-C), avoiding the use of plastic bags.



Figure 2. Good vs bad practices (A - E). Packaging should allow a good circulation of water around the plants (A,B,C and D) as for the grapevine scion wood cuttings shown in the images. Credits: P. La Notte (CNR-IPSP, IT), M. Zink (DLR Rheinpfalz, DE) and A.G. Delle Donne (Regione Puglia, IT).

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The target temperature (50°C) after immersion and the treatment duration (45 min) should be respected. Since after immersion of the plant materials the temperature of the water may decrease below 50°C, the duration of treatment should be recorded only once the water temperature has returned to 50°C.

The water in the tank should be changed regularly according to the frequency of treatments and the type of material undergoing thermotherapy, but at least once a day, in order to avoid excessive accumulation of residues and the consequent compromise of the water's circulation.

2.3.3 Post-treatment

After treatment, plant material should be preferably cooled slowly by spraying (not submerging) with water at room temperature or in any case above 12°C or alternative left to return to room temperature for 12–24 h in a humid and aerated conditions before rooting/grafting or packaging (Figure 3). Direct contact with cold water should be avoided as it may result in increased mortality or cross infection by pathogens (Boudon-Padieu & Grenan, 2002; Waite & Morton, 2007).



Figure 3. Plant material slowly cooled by spraying. Credit: Pierfederico La Notte (CNR-IPSP, IT)

A short time storage in a cold chamber may be carried out prior to rooting/grafting or planting. When HWT is performed on rooted plants, the storage period should preferably not be shorter than 6 weeks in order to limit additional stress caused by temperature fluctuations (Zink & Eder, 2022). Long-term storage after treatment (e.g., more than 6 months) should be avoided as it might cause a decrease in vitality.

2.3.4 Equipment

Equipment should be specially designed to maintain exactly the required temperature throughout the plant material, by an efficient water circulation and mixing system (Figure 4). An adequate equipment is described in EPPO PM 10/18 '*Hot water treatment of grapevine to control grapevine Flavescence dorée phytoplasma*'. Temperature sensing and recording systems should provide a combined overall accuracy of not more than ±0.5°C at the target treatment temperature (50°C), with a resolution of at least 0.2°C (i.e., the combined sensing

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and data recording systems should be accurate to within 0.5°C of the true temperature and must be able to be read in increments of 0.2°C or less). The equipment functioning and in particular the sensing and recording system should be checked regularly (Section 2.5. *Administration of the treatment procedure*).

Ideally, three sensors should be used for each tank. One sensor should be located at approximately 100 mm above the base of the tank, another at 100 mm from the surface, and the third inserted into the center of the load mass (Metlitskiy, 2002). This ensures the verification of uniform temperature distribution in the tank, and the detection of a defective sensor. In practice, the third sensor may not be necessary if the circulation of water is appropriate.



Figure 4. Treatment equipment. (A) Credit: Pierfederico La Notte (CNR-IPSP, IT). (B) Credit: M. Zink (DLR Rheinpfalz, DE).

2.3.5 Transportation

The treated material is preferably placed for transport in high humidity conditions. If external temperatures are high (e.g., above 15°C) and transport is long (e.g., more than 48h), this increases the risk of fungi and bacteria development or desiccation of the material or dormancy breaking, it may be necessary to place the plant material in a refrigerated compartment during transport.

2.4 Efficacy of treatment

Management of *X. fastidiosa*, regardless subspecies, includes control of the bacteria, as well as of the vectors, in particular the ones capable of laying eggs on woody dormant propagating materials.

X. fastidiosa growth, biofilm formation, and thermotolerance may vary depending on the subspecies and strain (Feil & Purcell, 2001; Román-Écija *et al*., 2021; 2025). However, studies conducted on several strains belonging to five subspecies (*fastidiosa*, *multiplex*, *pauca*, *sandyi* and *morus*) and several sequence types revealed a common pattern in post-stress recovery capacity at suboptimal temperatures from 4-10 and 32-40ºC (Román-Écija *et al*., 2021; BeXyl

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future publication).

In the framework of the BeXyl project (unpublished data), *in vitro* studies were performed to evaluate the tolerance of eight strains of the subspecies *fastidiosa*, *multiplex* and *pauca* exposed to high temperatures (42, 44, 45, 46, 47, 48 and 50ºC) during exposition times of 20 and 60 min (similar to those used for HWT of plant material). Results demonstrated that 48 and 50°C for both exposition times completely inhibited bacterial growth and biofilm formation. The bactericidal efficacy of HWT was also confirmed in planta using grapevine cuttings from plants naturally infected by *X. fastidiosa* subspecies *fastidiosa* ST1, which were treated at 48°C and 50°C for 45 min [additional testing for 30' is ongoing within BeXyl project].

HWT against *X. fastidiosa* is already officially recognized in the EU only for grapevine, in accordance with the EFSA Opinion "*Scientific Opinion on Hot water treatment of* Vitis *sp. for Xylella fastidiosa*" (EFSA PLH Panel, 2015) and implemented through Commission Implementing Decision (EU) 2015/2417 and Commission Implementing Regulation (EU) 2020/1201. In the United States, HWT is also recognized by the United States Department of Agriculture (USDA) and other authorities, including the California Department of Food and Agriculture (CDFA, 2023) for grapevine.

Experiments evaluating the impact of 50°C for 45 min, as well as two more extreme conditions on dormant bare-rooted grapevine plants (50°C for 60 min and 55°C for 45 min; La Notte *et al*., 2017) and grapevine woody cuttings (50°C for 60 min and 53°C for 45 min; BeXyl, unpublished data), representing a wide panel of varieties and rootstock combinations, demonstrate that the proposed HWT is generally well-tolerated and does not significantly affect the viability of the grapevine propagation material. In the framework of BeXyl project, the HWT at 45°C for 45 min (ongoing experiments at 48°C, BeXyl) in 3 consecutive years, was positively tested on self-rooted plants and cuttings of *Ficus carica* (totally 12 cultivars representating the wide fig biodiversity) and *Morus alba* (totally 7 cultivars) without statistically significant reduction in plant viability and rooting capacity (BeXyl unpublished data). [Experiments are ongoing on *F. carica* infected by *X. fastidiosa* at 50°C for 45min]. In pecan woody cuttings, HWT at 46°C for 30 min resulted in a high proportion of grafting success with a near elimination of *X. fastidiosa* (1 positive out of 140). Only minimal damage was observed on one cultivar treated at 50°C, but damage was common in three of the four cultivars when treated at 52°C (Sanserlin & Melanson, 2008; Melanson & Sanderlin, 2013).

For woody cuttings and bare-rooted plants of less than 3 cm diameter, it is considered that wood structure would not affect significantly heat penetration in the plant [ongoing experiment, BeXyl]. If plant viability and rooting capacity is demonstrated for other host species at 48°C/50°C x 45 min [under investigation at 48°C], it is considered that the treatment conditions would be appropriate for eliminating *X. fastidiosa* in this material. This is the reason why the current Standard also covers white mulberry. For larger diameters, especially at the grafting point, the time of treatment should be extended to guarantee a uniform distribution across all xylem cylinders. [To add more information on the time needed to reach the center of the cane when diameter exceeding 3 cm: ongoing experiment in the BeXyl Project].

HWT of 50°C for 45 min is also effective in eliminating vector eggs, primarily those of the leafhopper *Scaphoideus titanus*, the vector of Flavescence doré on grapevine (Schaub, 2010; EPPO PM 10/18). It is also effective against eggs (and other development stages) of all potential

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X. fastidiosa vectors, in particular sharpshooter species that could lay eggs on the surface of woody dormant propagating material (Bethke et al., 2001; Blua *et al*., 1999; Gould *et al*., 2004a&b; Purcell & Saunders, 1999).

In grapevine, this HWT is also effective against the grapevine phylloxera (*Viteus vitifoliae= Daktulosphaira vitifoliae*) (see also Short-duration hot water treatment, PM 10/16) and other insects such as eriophyids and scale insects (EPPO, 2009). Furthermore, it eliminates or reduces the incidence of several endophytes (Waite & Morton, 2007), including the stolbur phytoplasma ('*Candidatus Phytoplasma solani*', causing Bois noir disease), *Agrobacterium vitis*, *Xylophilus ampelinus*, as well as several fungi associated with grapevine trunk diseases such as *Phaeomoniella chlamydospora* (Fourie & Halleen, 2004; Gramaje *et al*., 2009), certain *Botryosphaeriaceae* species (Elena *et al*., 2015), and black foot pathogens such as *Cylindrocarpon*/*Ilyonectria*-like species (Bleach *et al*., 2013). However, efficacy varies among taxa, with some *Botryosphaeriaceae* species showing tolerance.

Similarly to grapevine, and based on the available literature about the HWT efficacy against specific or closely related harmful organisms in other crops, it is advisable to experimentally evaluate the effects of this treatment on additional target organisms in *Ficus carica, Morus alba* and *Carya illinoinensis*. For fig, potential targets including fig mosaic disease caused by viruses (Çağlayan *et al*., 2009; Bayoudh *et al*., 2017), the mite *Aceria ficus* (Szendrey *et al*., 1995); some fungi such as *Fusarium* spp. and *Phomopsis cinerascens*; root-knot nematodes such as *Meloidogyne* spp. (Lear & Lider, 1959; McKenry & Anwar, 2006); and insects occurring on the woody canes such as *Ceroplastes rusci* and other coccids/mealybugs (Haviland *et al*., 2005). For white mulberry, potential targets include: the bacterium *Pseudomonas syringae* pv. *mori* (Cappellozza *et al*., 2019); phytoplasma associated with mulberry dwarf disease (Tahama, 1968); fungi including *Mycosphaerella mori*; nematodes such as *Meloidogyne incognita* (Sharma & Sharma, 1987); and coccids such as *Pseudaulacaspis pentagona (*Gould & Hallman, 2001). For pecan, potential targets could include the fungus *Fusicladium effusum* agent of pecan scab disease, as well as mites and scale insects (Melanson & Sanderlin, 2015).

However, the described HWT does not prevent reinfection by soilborne plant pathogens if the treated material is planted in infected areas or is subsequently exposed to infected vectors.

Some doubts and reluctance concerning the use of HWT exist in some countries, mainly among nurserymen, due to its potential negative effects on the vitality of woody propagation material. It has been shown that the genotype of scion and rootstock (Frausin *et al*., 1999; Graham 2007; Heller *et al*., 2022; Mannini 2007; Moretti *et al*., 2002; Tassart-Subirats *et al*., 2003; Waite & May 2005), as well in some cases the graft combination (Casterad *et al*., 2001; La Notte *et al*., 2017; Ozdemir *et al*., 2017), can influence susceptibility or tolerance to HWT. However, given the large number of existing varieties and the variability of operational conditions, the existing literature does not provide a comprehensive or consistent picture. Climatic and nutritional conditions of the mother plants or the propagated material, either before or after the treatment, also play a role (Gramaje *et al*., 2014, Hunter *et al*., 2015; Waite & Morton, 2007). Negative effects on plant vitality may be more directly linked to incorrect timing of wood collection, unsuitable material, or failure to comply with the pre- and post- treatment requirements (e.g., long-storage of more than half a year at low temperature) (Stressel *et al*., 2012).

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2.5 Administration of the treatment procedure

[EPPO Panel on Phytosanitary Measures to decide if such a section should be added to the agreed format on PM 10 Standards. For discussion at meeting in 2026-10]

HWTs may be used as a phytosanitary measure for regulated pests on regulated articles; e.g., in the context of export purposes, or to allow the movement of plants for planting from an area where *X. fastidiosa* is present to areas free from the pathogen. When used as a phytosanitary measure, treatment should be carried out under strictly controlled conditions ensuring its effectiveness (MAAF, 2015; MASAF, 2024). The treatment facility should be either operated by, or authorized and audited by, the National Plant Protection Organization (NPPO). Where authorization is granted by the NPPO, this should be in accordance with ISPM 45 '*Requirements for national plant protection organizations if authorizing entities to perform phytosanitary actions*' (IPPC, 2021). In particular, Authorization for the first year should only be granted following a satisfactory on-site inspection confirming that the treatment conditions (Section 2.3.2) are met. To maintain their approval, HWT facilities should be subject to regular on-site inspection of the treatment facility and/or documentary checks (e.g., every 1-2 years). Traceability, calibration and treatment requirements (see below) should be verified (e.g., sensors devices should be checked regularly by the NPPO or by an external structure). Any maintenance on the HWT equipment should be communicated to the NPPO.

ISPM 42 '*Requirements for the use of temperature treatments as phytosanitary measures*' (IPPC, 2018) provides technical guidance on application of HWTs as phytosanitary measures for regulated pests on regulated articles. This includes guidance on temperature calibration, monitoring and recording; prevention of infestation after treatment; requirements for treatment facilities; and documentation.

In particular, temperature sensors devices should be calibrated according to international standards (ISO/IEC 17025). Records should be maintained for all plant material subjected to HWT and should include:

- details of suppliers of plant material (grower, packer, and place of production), including copies of any transport documents copies accompanying the consignment, when relevant,
- identification of the treatment facility,
- identification of the commodity treated (plant species, cultivar, type of propagation material and lot number, where applicable),
- target regulated pest(s),
- date of treatment,
- treatment condition records (bath temperature and duration, records generated by the HWT equipment),
- quantity of the material treated (e.g., number of plants, articles, packages, lot size or volume, as appropriate),
- details of any observed deviation from the prescribed treatment schedule,
- calibration records for temperature sensors and monitoring equipment,
- identifying marks or characteristics ensuring traceability between the treated plant material and the corresponding treatment condition records.

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HWT facilities should maintain, for each production cycle, a register to collect these records; together with the copies of HWT certificates issued. Records should be retained for a minimum period of X [3 years in IT – in Italy it is maintained in a national register maintained by the NPPO in the context of certification of plant reproductive material; 5 years in FR. To be discussed at a later stage by the Panel on Phytosanitary Measures] years.

2.6 Enquiries

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