REPORT

Bali, Indonesia
23-27 June 2014

Technical Panel on Phytosanitary Treatments

June, 2014

Food and Agriculture Organization of the United Nations

CONTENTS

LIST OF APPENDIXES

1. Opening of the meeting

Welcome by the IPPC Secretariat

[1] The Director General of the Indonesian Agency of Agricultural Quarantine, Ms Banun HARPINI, welcomed the participants to Bali and thanked the local authorities and the IPPC Secretariat for organizing the meeting. She also expressed appreciation to all the TPPT members for the important efforts they make to develop phytosanitary treatments that provide alternatives to methyl bromide fumigation, which is of major concern to Indonesia. She informed the TPPT that Indonesia in cooperation with Australia have implemented the Australian Fumigation Accreditation System (AFAS) to avoid as much as possible double treatment of goods with methyl bromide (pre and border). She recognized that there are several challenges to developing alternative treatments to methyl bromide such as chilling injury caused by cold treatments when not applied correctly. She stressed how important it would be to Indonesia to have the cold treatments adopted by CPM.

[2] The Host, Mr Antario DIKIN, welcomed the participants of the Technical Panel on Phytosanitary Treatments (TPPT) meeting to Bali, and wished the participants a good and productive meeting.

[3] The IPPC Secretariat (hereafter Secretariat) thanked Ms HARPINI for hosting the meeting and also welcomed the participants.

[4] The panel members and Secretariat staff introduced themselves and briefly described their positions and roles in their home organizations.

Election of the Chair

[5] The panel elected Mr Andrew JESSUP (Australia) as Chair. Mr JESSUP thanked the host organization for arranging the meeting in Bali.

Election of the Rapporteur

[6] The panel elected Mr Mike ORMSBY (New Zealand) as Rapporteur.

Adoption of the Agenda

[7] The panel reviewed and adopted the agenda (Appendix 1).

2. Administrative Matters

Documents list

[8] The panel reviewed and updated the documents list (Appendix 2).

Participants list

[9] Panel members reviewed their contact information (Appendix 3) and agreed to update it on the International Phytosanitary Portal (IPP – www.ippc.int).

Local information

[10] The meeting organizer provided further information and answered logistical questions regarding the meeting and its location[1].

3. Updates from Relevant Bodies

[11] The Secretariat presented an update from the 2014 May Standards Committee (SC) meeting[2] informing the panel about decisions taken by the SC in regard to the TPPT work programme. He

[1] 04_TPPT_2014_JunRev2

[2] 05_TPPT_2014_Jun; SC May 2014 Report is available at https://www.ippc.int/publications/2014-05-report-standards-committee

informed that since the SC assigned stewards and assistant stewards for the new topics, Mr David REES (Australia) has resigned and a new steward will need to be assigned for the draft ISPM on *Requirements for the use of modified atmosphere treatments as a phytosanitary measure* (2014-006), and a new Assistant steward will need to be assigned for the draft ISPM on *Requirements for the use of chemical treatments as a phytosanitary measure* (2014-003).

[12] The Secretariat highlighted the SC decision that TPPT position papers would now be approved by the SC and then made public. In this context, it was recalled that regarding the position paper on *acceptance of historical data* presented to the SC May 2014[3], the TPPT Steward was expecting comments from SC members to be incorporated into the paper, which would then be presented again to the SC. The need for the position had arisen from the fact that some treatment submissions would include historical data to prove the efficacy (and not only to evidence the historical international trade), and the TPPT would not support these submissions because there would not be a statistical basis for determining some level of efficacy, e.g. when efficacy data exist in relation to sampling under operational conditions.

[13] The panel expressed concerns about the SC discussion regarding not having a call for treatments in the near future. In 2017 there will tentatively only be four treatments left on the work programme, and the panel felt that additional treatments should be called for. The Secretariat recalled that the limitation is based on resource constraints, and that five standards for requirements are now likely will be drafted by the TPPT. However, the panel felt that drafting of these standards should not prevent the submission of new treatments. The panel also noted that drafting of new treatments (having deleted the original phytosanitary treatment topics from the *List of topics for IPPC standards*, there are now no limits to the treatment types), would also ensure that the correct experts be selected at the forthcoming call for experts (i.e. based on the actual treatments that would be developed). Furthermore, it would be opportune to receive additional cold treatment submissions to support the development of a wide range of cold treatments, which was one of the concerns expressed by some contracting parties in the formal objections received in 2012 and 2014. As to the resource constraints, the panel queried these. The Secretariat explained that these are due to limited staff resources to handle the standard setting process and the funding needed for translations.

[14] While understanding the resource constraints, the TPPT strongly encouraged additional calls for treatments.

[15] The Secretariat highlighted the major appreciation the SC had expressed toward all members of the TPPT for the enormous work done. The Secretariat informed the panel that, after this meeting, Mr Artur SHAMILOV will be replaced by Mr Nuri NIYAZI as Secretariat lead for the TPPT. The panel thanked Mr SHAMILOV for his hard work over the past years.

[16] The TPPT:

(1) considering the need for alternative treatments to methyl bromide fumigation treatments, the outcomes from the Expert Consultation on Cold Treatments (Buenos Aires, 2013) and the current TPPT work programme, *invited* the SC to consider issuing a call for treatments in 2015.

(2) *invited* SC to note that the TPPT selected Mr Guy HALLMAN (USA) to act as liaison between the TPPT and the Phytosanitary Temperature Treatments Expert Group (PTTEG) to exchange information on the research of temperature treatments to help support the development of international phytosanitary treatments.

(3) *invited* the SC to approve the position papers developed over the years, namely:

   a. Most thermotolerant stage of Tephritidae

   b. Presence of live adult insects after irradiation phytosanitary treatment

(4) *noted* the update.

[3] 21_SC_2014_May

4. Review of Cold treatments

[17] The Secretariat summarized the main issues of the formal objections received to the seven cold treatments that had been presented for adoption to CPM-7 (2012) and (CPM-9 (2014)[4], the latter also having briefly been discussed in the SC May 2014 meeting. The TPPT reviewed and modified the responses to the formal objections of the individual draft treatments[5]. The responses will be submitted to the SC for their endorsement and following made public.

[18] Cold treatment that received formal objections before CPM-7 (2012) and was not submitted for adoption at CPM-9 (2014):

- Cold treatment for *Ceratitis capitata* on *Citrus reticulata* cultivars and hybrids (2007-212)[6]

[19] Cold treatments that received formal objections both before CPM-7 (2012) and before CPM-9 (2014):

- Cold treatment for *Bactrocera tryoni* on *Citrus sinensis* (2007-206E)[7]
- Cold treatment for *Bactrocera tryoni* on *Citrus reticulata* x *C. sinensis* (2007-206F)[8]
- Cold treatment for *Ceratitis capitata* on *Citrus paradisi* (2007-210)[9]

Cold treatments that received formal objections before CPM-9 (2014):

- Cold treatment for *Ceratitis capitata* on *Citrus sinensis* (2007-206A)[10]
- Cold treatment for *Ceratitis capitata* on *Citrus reticulata* × *C. sinensis* (2007-206B)[11]
- Cold treatment for *Ceratitis capitata* on *Citrus limon* (2007-206C)[12]
- Cold treatment for *Bactrocera tryoni* on *Citrus limon* (2007-206G)[13]

[20] It was noted that the formal objections submitted before CPM-7 (2012) had been submitted also before CPM-9 (2014), in spite of having been addressed by the TPPT and responses having been submitted to the SC previously, along with the recommendations for CPM adoption of these treatments.

[21] In this context, the TPPT expressed concern about the lack of active participation from some contracting parties in the standard setting process, which may result in situations where a significant amount of work is carried out by the technical panel over a number of years but where consensus is nevertheless not reached and the treatments not adopted. It was also recalled that the treatments are developed as options for countries, and that they are not mandatory (cf. footnote 1 of all phytosanitary treatments). The lack of consensus would appear to be partly due to a differing interpretation and understanding of the treatment development, evaluation and implementation processes. The TPPT agreed to invite the SC to consider emphasizing this to contracting parties.

[22] The TPPT discussed the following issues in detail:

[23] **Data evidence based on one or two research papers only not deemed sufficient**. The TPPT discussed the objections and agreed that one paper comprising a number of studies is enough to support the treatment if it provides sufficient evidence of the treatment efficacy and meets the

[4] 07_TPPT_2014_Jun

[5] 08_TPPT_2014_Jun

[6] 2007-212_Draft Treatment; 2007-212_Treatment Portfolio; 2007-212_Reference_Argentina

[7] 2007-206E_Draft Treatment; 2007-206E_Treatment Portfolio

[8] 2007-206F_Draft Treatment; 2007-206F_Treatment Portfolio

[9] 2007-210_Draft Treatment; 2007-210_Treatment Portfolio

[10] 2007-206A_Draft Treatment; 2007-206A_Treatment Portfolio

[11] 2007-206B_Draft Treatment; 2007-206B_Treatment Portfolio

[12] 2007-206C_Draft Treatment; 2007-206C_Treatment Portfolio

[13] 2007-206G_Draft Treatment; 2007-206G_Treatment Portfolio

requirements stated in ISPM 28:2007 (*Phytosanitary treatments for regulated pests)*. The panel confirmed that this had been the case for all the studies used for the references in the treatments.

[24] Nevertheless, the TPPT found that it would be helpful that the schedules reference all the information that directly influences the TPPT review of the treatment. Hence, where supplementary data (unpublished or by anonymous authors) had been provided this was noted in brackets after the publication it related to.

[25] **Extrapolation of data to be applied to other cultivars.** The TPPT had previously considered data that indicated varietal differences in the treatment schedules for *Citrus sinensis*, for which reason the TPPT had included in their working criteria that varietal differences for *Citrus sinensis* cultivars should be considered. However, the TPPT had also noted on that occasion that the available data was insufficient and had requested additional information from the submitter, which remains outstanding.

[26] With reference to ISPM 28:2007 section 3.2.1, other cultivars should be taken into consideration only when there is evidence that varietal differences may impact treatment efficacy.

[27] Panel members discussed again the delineation of cold treatments for orange cultivars (rather than at citrus species level). The panel noted that the Phytosanitary Temperature Treatments Expert Group (PTTEG) will be reviewing the literature supporting this position and one possible outcome is that it may recommend that the TPPT no longer delineate cold treatments at the cultivar level for oranges. Should this occur or should new research be made available supporting cold treatments at the species level, TPPT will change its position on this issue. Until that occurs, schedules for cold treatments on oranges (only) will continue to be set at the cultivar level. (See also discussion reported under 9.2 *TPPT Working criteria for treatment evaluation*).

[28] The panel discussed potential cultivar differences in cold treatment efficacy in *C. paradisi* (2007-210). The TPPT was aware that there may be studies attesting to some differences in cultivars, but it is not clear whether these are due to tolerance to cold, differences in the experimental design or other reasons. Considering the potential impact on trade – should all cultivars be considered separately – and the fact that no empirical evidence was currently available to the panel, the TPPT found that the requirements of ISPM 28:2007 section 3.2.1 had been met.

[29] The treatment was modified as regards the references in the schedules for consistency with other adopted treatments.

[30] **Lack of supporting data for schedule 2 in 2007-210**. The TPPT clarified that the supporting data for this schedule had been inadvertently omitted. The original submission made in 2007 included two references authored anonymously. These references were replaced by papers authored by Willink *et al.* (2007a and b). However, they lacked data pertaining specifically to schedule 2. The two anonymous reports containing the missing data will be added to the proposed schedule.

[~~31~~] **Regional differences in cold tolerance.** The TPPT discussed the potential differences in fruit fly populations (within species) that may result in variations in cold tolerance. While cold tolerances are evident from a regional spread perspective, this has not been shown to be significant for cold treatments. The TPPT noted that the PTTEG will explore this issue.

[32] **Artificial infestation in relation to cold tolerance.** In July 2013, the TPPT agreed that artificial infestation would be considered satisfactory only when the pest developmental stage tested had developed in the fruit (e.g. eggs placed and larvae tested). However, the TPPT had received data, together with the formal objections, that gave some evidence of a suitable treatment schedule of significantly shorter time than that proposed in the data that the TPPT had previously evaluated. The TPPT considered that use of artificial infestation may have raised the cold tolerance of the fruit flies resulting in survivors at the exposure times. Since the PTTEG will evaluate the issue of artificial diet and regional population effects on cold tolerance, the TPPT agreed to defer recommendation on this issue until a review of this issue has been carried out.

[33] **Pre-cooling.** The TPPT agreed that reference to pre-cooling should be taken out of the draft treatments because it is an operational requirement and not part of the schedule. Pre-cooling, temperature monitoring and recording are important operational issues, and they will be addressed in the specification for the draft standard on *Requirements for the use of temperature treatments as a phytosanitary measure* (2014-005). This operational ISPM will enhance the implementation of the treatment schedules but the schedules are not dependent on them (if the schedule is met, then the treatment will work).

[34] **Life stage tolerance of fruit flies to cold treatments.** The panel agreed that there are methodology variables at play in conducting cold treatment studies that could account for different results including potential differences in cold tolerance by fruit fly populations from different geographic locations. For example, the infestation methods used in the experiments, age and condition of fruit fly colony, condition of fruit at time of testing, differences in equipment/sensors used (sensitivity, precision, accuracy, etc.), potential cross-contamination, and treatment end points. In regard to the most tolerant larval stage of *C. capitata* differences were noted between the test results in the references, and the TPPT confirmed that this is indeed the case. The literature is not consistent concerning the most cold-tolerant life stage of *C. capitata* and a discussion paper had been prepared on this for the Expert Consultation on Cold Treatments (Buenos Aires, 2013).

[35] The TPPT further noted that a degree of over-treatment usually occurs for the cold treatment schedules that would easily account for any differences in cold tolerances between the larval life stages. Hence, the treatment will usually achieve or exceed the needed efficacy for larval life stages regardless of which is the most cold tolerant.

[36] **Amendments to the phytosanitary treatments.** When discussing the formal objection for 2007-206A, the panel noted that it is foreseen that several schedules will be submitted in the future for the same fruit (different cultivars) and pest. The TPPT recognized that due to this issue, it would be opportune for the treatments to remain on the TPPT work programme, also after possible adoption, so that these can be amended as data for new schedules are made available. This would be a situation comparable to the *Amendments of the Glossary* (1994-001), i.e. where only the new schedule would be open for comments in the standard setting process. The amendments to the phytosanitary treatment would be related to the schedules only and be submitted via the normal standard setting procedure.

[37] The panel reviewed the wording of the cold treatment schedules, namely "2 °C or below for 18 continuous days" and decided the following wording was more appropriate: "2 °C or below for no less than 18 continuous days" because it better reflects the limitations of the treatment and avoids an interpretation that requires the treatment to needlessly end at 18 days. This is same argument as in the cases where treatments state "2 °C or below". The draft treatments for *Bactrocera tryoni* were modified accordingly.

[38] **Chilling injuries and general applicability of the cold treatment.** The applicability during long journey times of the schedule in 2007-206C was found by a contracting party to result in chilling injuries to the fruit. The TPPT confirmed the efficacy of the treatment and that it is widely applicable to international trade, hence in accordance with section 3.3 of ISPM 28:2007. The issue raised by the formal objection relates to operational challenges. The TPPT reviewed evidence to support that the issue could be solved with improved application of the treatment[14].

[39] For reasons evidenced in the discussions above and in the TPPT responses to the formal objections which will be forwarded to the SC, the TPPT decided to work further on the following cold treatments and not forward them to the SC for adoption by the CPM:

- *Ceratitis capitata* on *Citrus sinensis* (2007-206A)
- *Ceratitis capitata* on *Citrus reticulata* × *C. sinensis* (2007-206B)

[14] Paper available at: https://www.ippc.int/work-area-publications/lemon-fruits-export-japan-under-cold-treatment-argentinean-experience-stein

- *Ceratitis capitata* on *Citrus limon* (2007-206C);
- *Ceratitis capitata* on *Citrus paradisi* (2007-210)
- *Ceratitis capitata* on *Citrus reticulata* cultivars and hybrids (2007-212)

[40] The TPPT:

(5) *recommended* the cold treatments as modified in this meeting for: *Bactrocera tryoni* on *Citrus sinensis* (2007-206E); *Bactrocera tryoni* on *Citrus reticulata* × *C. sinensis* (2007-206F); *Bactrocera tryoni* on *Citrus limon* (2007-206G) to the SC for adoption by the CPM.

(6) encouraged contracting parties to submit any data to support the TPPT analysis on *Ceratitis capitata* cold tolerance on *Citrus sinensis, C. reticulata* × *C. sinensis,* and *C. paradisi.*

(7) *encouraged* the PTTEG to communicate outcomes from their analyses on cold tolerance in fruit flies (regarding both regional differences and cultivar delineation) to the TPPT at the earliest possible occasion.

(8) *invited* the SC to review the TPPT responses to the formal objections on cold treatments received before CPM-9 (2014) for their endorsement as appropriate.

(9) *invited* the SC to remind contracting parties that there is no obligation for a contracting party to approve, register or implement the IPPC phytosanitary treatments for use in its territory and consider adding this as a note in the response to the formal objections.

(10) *invited* the SC to consider the possibility of amending phytosanitary treatments, amendments to be submitted through the normal standard setting procedure, to include additional schedules as data become available.

5. Review of irradiation treatments from member consultation

5.1 Irradiation for *Dysmicoccus neobrevipes, Planococcus lilacinus* and *Planococcus minor* (2012-011)

[41] The TPPT reviewed the draft treatment, treatment portfolio, 2014 member comments and draft treatment lead responses, and TPG recommendations[15]. The Treatment lead clarified that a number of comments were related to conclusions reached in specific papers as referenced in the treatment and that IPPC members asked for additional clarifications or supporting evidence. He explained that other references listed provided this and did not refer to additional papers for that reason.

[42] Specifically, the main concern was the absence of data on comparison of radiotolerance and confirmatory testing among all three species. In response to the member comments, the submitter forwarded information related to two papers. One published article which demonstrated that *D. neobrevipes* is the most radiotolerant of the three species; one unpublished paper which demonstrated that confirmatory testing (n=~35,800) at a target dose of 200 Gy was successful against *D. neobrevipes*, with a maximum dose of 231 Gy. It was noted that this information will be published by the end of 2015 in a special journal issue of the Florida Entomologist related to a FAO/IAEA Coordinated Research Project on generic phytosanitary irradiation.

[43] Treatment evaluation was provided for the draft treatment (see Appendix 4).

[44] The TPPT:

(11) *recommended* the Irradiation treatment for *Dysmicoccus neobrevipes*, *Planococcus lilacinus* and *Planococcus minor* (2012-011) to the SC for submission to the CPM for adoption.

[15] 2012-011_Draft Treatment; 2012-011_TreatmentPortfolio; 10_TPPT_2014_Jun; 09_TPPT_2014_Jun

6. Review of wood treatments for member consultation

6.1 Sulfuryl fluoride fumigation of wood packaging material (2007-101)

[45] The Treatment lead introduced the updated checklist, the treatment portfolio and the submitter response[16].

[46] Based on consultation with pine wood nematode (PWN) experts, the panel discussed three options to move forward:

[47] 1. Requesting data from the submitter supporting the assumptions that eggs are the most tolerant life stage and time in egg life stage is the determinant for treatment duration. Considering the submitter had already indicated that it was not likely to obtain further funding for research, this was not deemed a viable option.

[48] 2. Accepting the hypothesis that eggs are the most tolerant life stage and time in egg life stage is the determinant for treatment duration, and submitting the treatment as it is to the SC. This was considered a theory to explain the results but had not as yet been proven through research.

[49] 3. Separate the treatment into one for insects (with a less severe schedule) and one for PWN and insects (with a more severe schedule) because this would make the treatments more targeted and prevent unnecessarily high dosing of timber not infested with PWN. The TPPT reviewed this proposal[17] and agreed with this approach.

[50] Modifications to 2007-101A:

[51] One member raised concerns that Sulfuryl fluoride (SF) treatments cannot penetrate wood with high moisture content and that the methods to measure moisture content are not accurate. The panel discussed the methods used to measure moisture content and their limitations. It was finally agreed that the moisture content of wood can be achieved with a level of accuracy suitable for use for this treatment schedule. It was also recognized that the treatment efficacy had been demonstrated to be effective on wood with moisture content no greater than 60%. It was felt that measuring the moisture content is an operational aspect that can be handled by different means, for instance by ensuring a much lower than required content is achieved through kiln-drying the wood. Additionally, it was stressed that sawn wood loses moisture rapidly and in most cases after only a few days will have moisture content less than 60%.

[52] The **target pest** was changed to *wood-borne insects* for precision. The **target regulated article** was modified to *debarked wood, not exceeding 20 cm in cross-section and not exceeding 60% moisture content* in line with the scope.

[53] A member queried why *final* had been added to *minimum concentration*. *Final* was deemed unnecessary and taken out of the schedule. The panel discussed whether a **minimum concentration** should be required throughout the treatment or a requirement of periodic readings of the gas concentration should be added because the concentration-time product (CT) value varies depending on when it is measured, in order to assure the treatment would be appropriately applied. Some members felt that guidance should be provided to NPPOs because of the possible great variations in CT, which could result in treatment failure. It was also not clear how the CT is measured throughout the process. A higher initial dose could be used to achieve the CT in less time. It was suggested to add a schedule example, but others felt that this would not be appropriate for a standard because all the different variables could not be taken into account (e.g. type of enclosure and loading factor).

[54] Others felt that this was an operational requirement and should not be added as a treatment requirement. NPPOs should independently devise models to calculate the concentration in order to achieve the CT needed to meet the requirements of the treatment. Some suggested using the same

[16] 2007-101 Updated Checklist; 2007-101_Draft Treatment; 2007-101_TreatmentPortfolio

[17] 2007-101A_DraftISPMInsectsSulfurylFlouride; 2007-101B_DraftISPMPWNSulfurylFlouride

wording as for the schedules in ISPM 15:2009 (*Regulation of wood packaging material*). A minimum final concentration ensures that there has been a 24 hour exposure, and not only a high initial concentration leading to the minimum CT that would quickly disappear. The panel finally decided to not add minimal initial dose in consistency with ISPM 15:2009. Should IPPC members wish to add this information, suggestions to do so could be added in member consultation and the panel would then reconsider.

[55] To aide with operational implementation, an example schedule had been provided in the treatment, which also included the initial concentration. It was clarified that the example was built from research made on sawn wood.

[56] It was agreed to add a footnote on how the **minimum level of mortality** was calculated for a specific species, because extrapolation from a model fitted to the experimental data was used only to calculate this species' mortality level, and the panel found that this should be clear due to the great difference between calculation methods in the efficacy.

[57] The draft was modified not to include **operational requirements**, which should be included in the draft ISPM on *Requirements for the use of fumigation treatment as a phytosanitary measure* (2014-004). Hence, the following were taken out: loading factor; sealing; gas mixture; absorption; coating of the wood; and record keeping.

[58] Modifications to 2007-101B:

[59] It was recalled that this treatment might be included in ISPM 15:2009.

[60] The changes to 2007-101A that were applicable also to 2007-101B were made.

[61] The schedule was modified to include a minimum final concentration over 48 h.

[62] Treatment evaluation was provided for both draft treatments (see Appendix 4).

[63] The TPPT:

(1) *recommended* the draft PT for *Sulfuryl fluoride fumigation of insects in debarked wood* (2007-101A) as modified in this meeting to the SC for member consultation.

(2) *recommended* the draft PT for *Sulfuryl fluoride fumigation of nematodes and insects in debarked wood* (2007-101B) as modified in this meeting to the SC for member consultation.

6.2 Heat treatment of wood using dielectric heating (2007-114)

[64] The treatment lead introduced the draft treatment, submitter response, the updated checklist, additional references and the treatment portfolio[18] and explained that this draft had already gone for member consultation in 2011 but that it had then been put on hold until Annex 1 of ISPM 15:2009 on *Approved treatments associated with wood packaging material* (2013) had been adopted.

[65] Several papers and draft research reports on the use of radio waves in dielectric heating were discussed by the TPPT. The panel found there was sufficient information supporting the modification of the dielectric heating schedule to include larger wood pieces and a longer heating up time. Specifically because:

- Radio frequency (RF) uses much lower frequencies than microwaves (MW). So the RF wave has a longer penetration depth than the MW. Penetration depth affects the size and shape of treated wood. Thus, RF heating can be used to treat bulk material with relatively larger dimensions than MW heating[19].

[18] 2007-114_Draft Treatment; 2007-114_Additional Reference; 2007-114 Updated Checklist; 2007-114_TreatmentPortfolio

[19] Jiao, S. (2012). Development of non-chemical postharvest treatments for disinfecting agricultural products-PhD Thesis. Washington State University.

- Other notable characteristics of dielectric heating (DH) are the high power density and the potential for selectively heating materials[20]. In a heterogeneous material like wood, the component with the highest loss factor will in general absorb the bigger part of the energy. An effective application of this selective heating is DH of wood infested with pests. In a moist material, the heat will preferentially be developed in the water in wood and inside the pest's body. When the moisture content declines, less heat is automatically taken in, so overheating of the material is prevented. It seems likely, therefore, that the degree of selective heating of the insects obtained in the lower frequency range is much better than that obtained in the microwave range at 2.45 GHz. Dielectric heating offers an advantage over conventional heating for insect control due to the selective heating of insects[21].
- Increasing the RF power by 3-fold reduced run time (T60) by up to 78%[22]. Dielectric heating systems are reported to convert 50–70% of the energy to heat, in comparison to 10% efficiency in conventional ovens[23].
- RF can effectively penetrate beyond the 20 cm limit.. Using high power radio frequency (HPRF) heating wood sizes of up to 70 cm could reach 60 °C within 30 minutes. Extending the allowable heating time would enable 3 meter stacks of timber to be treated to 60 °C using HPRF heating within 2.5 hours (150 minutes)[24].
- Heat treatments of around 60 °C for 1 minute are generally effective against wood inhabiting insects, nematodes and fungi (NAPPO 2013). Further efficacy trials to show that wood pests are suitably treated at extended wood thicknesses or longer heating up times are not necessary if these temperatures are met.

[66] The Treatment lead clarified that only *Bursaphelenchus xylophilus* was included because the treatment had not been tested on other nematodes.

[67] The panel discussed elements in the draft schedule that were operational requirements, which could be added to the draft ISPM on *Requirements for the use of temperature treatments as a phytosanitary measure* (2014-005). Some members found that some of these should be included because the treatment is not otherwise practically applicable. Other operational requirements were taken out of the draft, e.g. in relation to auditing and monitoring.

[68] The panel discussed the feasibility of heating larger pieces of wood with dielectric heating. The panel agreed that the important aspect of the treatment is that "internal wood temperatures meet or exceed 60 ˚C for 1 minute throughout the profile of the wood", and that *how* this requirement is met should not be part of the schedule.

[69] Some members queried the need for adding "3 hours" heating-up time and why it had been changed from 30 minutes. It was clarified that it had been changed from 30 minutes because new data had been produced to demonstrate that this is an operationally viable heating-up time to reach 60 ˚C. Some members did not find that this should be in the schedule because there is no evidence that 60 ˚C for 1 minute would result in any survivors, meaning that it is not important for the treatment to clarify how to reach this efficacy. The Treatment lead presented an unpublished paper[25] that demonstrated that

[20] Laborelec, J C (2011) Application note dielectric heating. European Copper Institute Publication No Cu 0122 (www.leonardo-energy.org/drupal/node/1845)

[21] Nelson, S. O. (1996). Review & assessment of microwave energy for stored-grain insect control. *American Society of Agricultural Engineers*, 39(4):1475–84; Wang, S., J. Tang, J.A. Johnson, E. Mitcham, J.D. Hansen, G. Hallman, S.R. Drake, and Y. Wang (2003). Dielectric Properties of Fruits and Insect Pests as Related to Radio Frequency and Microwave Treatments. *Biosystems Engineering* 85(2): 201–12.

[22] Janowiak, J., Dubey, M., Hoover, K., Mack, R., Elder, P. (2014) Comparative Study of Radio Frequency (RF) & Microwave (MW) Heating of Wood in Compliance with ISPM-15 Phytosanitary Treatment.

[23] Jiao (2012). In development.

[24] Janowiak (2014) Comp. study.

[25] Jamieson, L.E, Waddell, B.C, Laidlaw, W.G., Rogers, D.J. Decay of thermal conditioning in *Bactrocera tryoni* eggs (Diptera: Tephritidae) following non-lethal heat treatment (in press.).

heating-up time may have an influence on the heat tolerance insects although the example involved eggs of *B. tryoni*, a pest of fruit not wood. However, the panel agreed that this only emphasized the importance of having a schedule of 60 ˚C for 1 minute.

[70] One member expressed concern with the schedule as presented in relation to treatment for nematodes due to the uneven distribution of the heat. The Treatment lead clarified that in dry wood, the dielectric heat is even more effective because the insects being wet they will be heated first. Additionally, the study on which the schedule is based, demonstrates that after a few minutes the heat would be evenly distributed.

[71] One member stressed that research results from this type of treatment are generally variable, and depend on several things such as the wood species or whether the wood is frozen. The member was concerned about putting forward a treatment when there is no absolute certainty that the treatment is practical and applicable. This potentially leads to treatment failure.

[72] The Treatment lead made analogies with kiln-drying, although the latter heats predictably which is not the case for dielectric heating. This needs to be accounted for in the operational part of the treatment.

[73] The panel finally agreed to delete mention of the heating-up time and the diameter of the wood.

[74] The descriptive authority was queried because there were two names. It was clarified that this is when the scientific name has changed.

[75] The panel discussed the treatment's efficacy level because some members did not find that efficacy should be assessed based on an extrapolation analysis alone, but in combination with confirmatory trials. However, for this treatment, confirmatory trials cannot be made and the panel expressed concern about the level of uncertainty. It was recalled that the Commission on Phytosanitary Measures did accept extrapolation analysis without confirmatory trials when adopting treatments under ISPM 15:2009. The panel found that it would be appropriate to develop a position paper on the use of extrapolation to estimate treatment efficacies (e.g. probit analysis).

[76] Treatment evaluation was provided for the draft treatment (see Appendix 3).

[77] The TPPT:

(3) *recommended* the draft *Heat treatment of wood using dielectric heating* (2007-114) as modified in this meeting to the SC for member consultation.

(4) *agreed* to develop a position paper on the *Use of extrapolation to estimate treatment efficacies* (e.g. probit analysis) and assigned Mr Guy HALLMAN (USA) as lead.

7. Review of Vapour Heat Treatment Related Issues

7.1 Characterization of heated air treatments

[78] The lead introduced the draft position paper[26], noting that the high temperature forced air (HTFA) treatments complexity issue had been added to the TPPT work programme at its April 2014 virtual meeting based on concerns voiced in the TPPT August 2013 e-forum discussion.

[79] He summarized the paper noting the differences between vapour heat treatments (VHT) and High temperature forced air treatments (HTFA), and factors that can affect efficacy of heat treatments and factors that may not be significant for commercial application. In addition the issue of temperature recording during experiments (e.g. highest temperature recorded during the confirmatory tests should be considered as a minimum requirement, minimum core temperature for the entire load and minimum time at that core temperature, heat-up time) was discussed.

[26] 11_TPPT_2014_Jun

[80] He noted that while VHT may seem a very fast treatment, this would not be the case for large quantities, i.e. commercial application.

[81] The panel agreed on what type of information a treatment schedule should contain and provided examples of VHT and HTFA treatment schedules (e.g. hydro cooling was not considered part of a schedule).

[82] The panel discussed whether to consider all heated air treatments under the same heading, recognizing that the form of heating (dry or wet heat) may affect heating-up time but that treatment efficacy is determined by the exposure temperature and time (not the heating-up time or the air moisture level). The panel noted that lower oxygen levels enhance the efficacy of a heat treatment, and a wet air treatment (VHT) may create lower internal oxygen conditions than dry air treatments (HTFA). If oxygen levels do differ between treatment types, then they should be kept separate. Theoretically there could be an issue of level of stress of the insects in wet versus dry fruit. Since there is no certainty on this, the panel did not find there was support to join the treatments under the same name. Possibly, the PTTEG will look further into this issue and inform the TPPT on the outcomes.

[83] The TPPT decided to have an e-forum discussion to collect comments on this paper.

[84] The TPPT:

(5) *agreed* to have an e-forum discussion on the IPP to collect comments on the draft position paper on *Characterization of heated air treatments*. The lead will incorporate the comments and present the paper for discussion at the next TPPT face-to-face meeting.

(6) *encouraged* the PTTEG to forward the outcomes of their discussions on the level of stress of the insects in wet versus dry fruit to the TPPT at their earliest convenience.

7.2 TPPT Recommendations for future research on high temperature forced air treatment

[85] The Treatment lead introduced the paper[27]. He noted that during the evaluation of the *High temperature forced air treatment for selected fruit fly species (Diptera: Tephritidae) in fruit* (2009-105) in the TPPT 2013 meeting, it was agreed that the panel would provide guidance to the submitting country on the research required to extend the treatment to other fruit fly species and hosts of interest to them in international trade. The paper concluded that the submitter can submit additional data in the future to add more fruit flies and fruits to the treatment and provided a recommendation on how to carry out this research.

[86] The panel discussed whether these recommendations would be applicable to all submitters and agreed that this would be decided on an on-request basis. Additionally, the recommendation should be formulated as suggestions and not requirements.

[87] The lead will modify the paper accordingly and the TPPT will then transmit it to the submitter, after having discussed it via an e-forum.

[88] The TPPT:

(7) *asked* the lead for *High temperature forced air treatment for selected fruit fly species (Diptera: Tephritidae) in fruit* (2009-105) to modify the paper and then submit it for a TPPT e-forum discussion.

(8) *asked* the Secretariat to transmit the modified paper as agreed to by the TPPT in an e-forum discussion to the submitter of *High temperature forced air treatment for selected fruit fly species (Diptera: Tephritidae) in fruit* (2009-105).

[27] 14_TPPT_2014_Jun

8. Review of Vapour heat treatments

8.1 Vapour heat treatment for *Mangifera indica* var. Manila Super (2009-108)

[89] The Treatment lead briefly introduced the draft treatment portfolio[28], noting that supporting data had been requested from the submitter after the TPPT 2013 face-to-face meeting, but that no reply had been received.

[90] The TPPT:

(9) *agreed* to send a final notice letter informing the submitter that the treatment will be recommended for removal from the *List of topics for IPPC standards* unless supporting data is submitted.

8.2 Vapour heat treatment for *Bactrocera tryoni* on *Mangifera indica* (2010-107)

[91] The Treatment lead introduced the draft treatment, updated checklist, treatment portfolio and the submitter response[29] noting that the submitter provided a sequence of studies conducted to support the treatment that included information, *inter alia*, on control mortalities, treatment temperature, treatment duration in confirmatory testing, and infestation methodology. The researchers identified that the egg is the most tolerant stage, and a large number of eggs in mangoes were killed with a very high degree of efficacy: $ED_{99.998}$ at the 95% confidence level. The Treatment lead noted that the treatment schedule can be readily implemented by industry without significant damage to the fruit and should result in a negligible risk of the pest successfully following the mango pathway to create an infestation.

[92] The panel discussed whether to change the schedule taking into consideration a paper[30] demonstrating that fruit flies may be conditioned to withstand heat better. However, the panel agreed that even if there may be some variation in thermal tolerance, this is overcome by the treatment's robustness.

[93] It was also noted that the measure of efficacy (treatment end point) is different for the treatment than was used in the treatment tolerance research and likely to be more robust (e.g. egg hatch vs pupal emergence).

[94] Treatment evaluation was provided for the draft treatment (see Appendix 3).

[95] The TPPT:

(10) *recommended* the draft Vapour heat treatment for *Bactrocera tryoni* on *Mangifera indica* (2010-107) to the SC for member consultation.

9. Other items from TPPT work programme

9.1 The concept and possible content of requirements for the use of phytosanitary treatments

Draft (generic) specification for ISPMs: Requirements for the use of phytosanitary treatments as phytosanitary measures (2014-008)

[96] The Steward introduced the draft generic specification for the ISPMs for *Requirements for the use of phytosanitary treatments as phytosanitary measures* (2014-008)[31] explaining that the SC May 2014 had agreed with the proposal of developing one specification for all five topics (2014-003, 2014-004, 2014-005, 2014-006, 2014-007), provided the specification clearly stated that five separate ISPMs

[28] 2009-108_TreatmentPortfolio

[29] 2010-107_Draft Treatment; 2010-107 Updated Checklist; 2010-107_TreatmentPortfolio; 2010-107_Submitter Response 2014

[30] Jamieson, L.E, Waddell, B.C, Laidlaw, W.G., Rogers, D.J. Decay of thermal conditioning in *Bactrocera tryoni* eggs (Diptera: Tephritidae) following non-lethal heat treatment (in press.).

[31] 23_TPPT_2014_Jun

would be developed and that specific expertise would be needed for the individual expert drafting groups.

[97] SC members had been encouraged to send comments to the TPPT Steward by 31 May 2014, and the comments received were discussed. One of the main concerns was that the draft specification should not contain elements of treatment development and evaluation.

[98] The TPPT provided the following comments for the Steward's consideration.

[99] Some found that procedures on **how to develop research** would be suitable for the ISPM. The panel suggested that the ISPMs should have a general section on research in consistency with ISPM 18:2003 *(Guidelines for the use of irradiation as a phytosanitary measure)*, and suggested a task be added to this effect.

[100] **Expertise section**. The TPPT discussed the advantages and disadvantages with having an expert drafting group (EDG) consisting of the full TPPT or only of some the members (i.e. an ad hoc EWG). Some were worried that their NPPOs would not be able to support an ad hoc EWG together with the support to the TPPT, which would result in some of the best experts not being available for the EWG. Others felt that the treatment development work was fundamental and that the TPPT should focus on this, and hence that an EWG was more appropriate, as there would not necessarily be enough time in a TPPT meeting to do both things. Some found that it was the TPPT's task to focus on those standards because they may be help to facilitate the adoption of treatments.

[101] The TPPT finally agreed to suggest that wording be added to the effect that the TPPT would draft the standards taking their workload and expertise available into consideration. It was furthermore suggested that the SC consider that the first standard to be worked on would be the *Requirements for the use of temperature treatments as a phytosanitary measure* (2014-005) because this could aid the development of cold treatments.

[102] The TPPT:

(11) *noted* the specification *Requirements for the use of phytosanitary treatments as phytosanitary measures* (2014-008) and *provided* some input to the Steward.

Requirements for the use of fumigation treatments

[103] The TPPT deferred work on this agenda item until the specification for this work has been formally approved.

Requirements for the use of temperature treatments

[104] The TPPT deferred work on this agenda item until the specification for this work has been formally approved.

Requirements for the use of modified atmosphere treatments

[105] The TPPT deferred work on this agenda item until the specification for this work has been formally approved.

Requirements for the use of irradiation treatments

[106] The TPPT deferred work on this agenda item until the specification for this work has been formally approved.

Requirements for the use of chemicals treatments

[107] The TPPT deferred work on this agenda item until the specification for this work has been formally approved.

9.2 Working TPPT criteria for treatment evaluation

[108] The TPPT reviewed and modified the TPPT criteria for treatment evaluation (Appendix 4), addressing the SC May 2014 concerns regarding the consistency of section 3.1 *Use of historical data* with ISPM 28:2007. Since the working criteria are updated in accordance with the TPPT position papers and since the SC now approves the TPPT position papers, the TPPT discussed the need for the SC to approve also the existing papers for them to be made publically available and the working criteria be correctly supported by the data analyzed in the past.

[109] Regarding section 3.1, the first sentence was modified to clarify that historical data may be used to support the general effectiveness of a treatment that has been in use for many years. It was noted that submissions must include specific data that demonstrates a particular level of efficacy. The TPPT stressed that the panel already considered historical data when applicable and appropriate, but agreed that the wording could be more clearly aligned to ISPM 28:2007. The TPPT also stressed that historical data may not provide evidence that a treatment is effective simply because it has been used, unless there are records of pests killed.

[110] A new section under 3 was added on experimental conditions that are suitable for international trade and text on mortality added to section 6 because it was found, after having developed instructions to assist NPPOs and RPPOs in proper and complete submissions, that this would align the evaluation criteria with these instructions.

[111] The panel modified the general considerations for temperature treatments to include cold treatments.

[112] Since the papers in 5.1 *Selected references* were not referenced in the text, the section was changed to *Selected reading*.

[113] Section 10.7, regarding the difference of cold tolerance in cultivars of *C. sinesis*, was discussed following the concerns raised under agenda item 4 (*Review of cold treatments*). Several members found that the criterion relating to cultivars of *Citrus sinensis* (orange) responding differently to cold treatments was not sufficiently supported by evidence to the effect that no other reasons could explain this difference, and therefore that the criterion should be deleted. The members feared that the decision taken in 2007[32] had been based on a potentially incorrect interpretation of the data.

[114] Others found that it would be inappropriate to delete it at this point because there is no firm evidence to state that it is not due to cultivar differences, and because they felt that the TPPT must have sufficiently examined the data at their meeting in 2007.

[115] Considering that the PTTEG will discuss the issue in detail, it was agreed that the TPPT should consider their conclusions before deleting or modifying the criterion or changing the treatment schedules where cultivars are considered (see agenda item 4).

[116] However, the TPPT softened the wording of the criterion to state that the data *may* have indicated that different cultivars responded differently to cold treatments. Lastly, a note was added to state that the TPPT is reviewing this criterion.

[117] The TPPT:

(12) *asked* the Secretariat to include the revised TPPT criteria for treatment evaluation (Appendix 5) in the IPPC Procedure Manual for Standard Setting at its next revision.

(13) *agreed* to review the section 10.7 of the TPPT criteria for treatment evaluation once the outcomes of the PTTEG discussion on difference of cold tolerance in cultivars of *Citrus sinesis* are available, and *asked* Mr Guy HALLMAN (USA) to transmit these outcomes to the lead for the TPPT working criteria.

[32] See TPPT 2007 meeting report for details.

9.3 Instruction to assist NPPOs and RPPOs in proper and complete submissions

[118] The lead introduced the paper on how to prepare appropriate and complete treatment submissions[33], noting that the need for the guidance had been raised in a previous TPPT meeting. The guidance was based fully on the TPPT working criteria. He highlighted also that it is the responsibility of the submitter to provide a complete and accurate submission in support of their proposed treatment. This includes the appropriate statistical analysis of the research results, including efficacy.

[119] He further introduced two scientific papers as input to discussions. The first one stated that replication should be made across seasons[34]. The panel agreed that replication is required for treatments submitted under ISPM 28:2007 but replication across seasons is not as relevant because they are experiments completed in a laboratory. The panel considered that all of the likely natural variations should be considered in treatment designs, including host size, host age, pest development, day length and temperature.

[120] The second one related to new research about treatment end points[35] and the fact that some treatments may have some survivors after the treatments but that will die after some time. When importing countries find potentially viable eggs in a consignment, this may seem as a treatment failure and the country may not accept the consignment. For this reason it is important to understand if the pests are going to die at a later stage.

[121] The panel stressed that the underlying principle of the guidance should be that researchers should incorporate any variation that may reflect the actual situations found in international trade.

[122] The panel wished to discuss the instructions further, and agreed that the members would provide comments to the lead who would then prepare a revised version to discuss in a virtual meeting.

[123] The TPPT:

(14) *agreed* to have an e-forum discussion on the *Instructions to the NPPOs and RPPOs in proper and complete submissions for phytosanitary treatments* to collect comments. The lead will then incorporate comments and prepare a revised paper for a virtual meeting.

9.4 Technical support document for the Glossary definition of *effective dose*

[124] The Secretariat introduced the issue of developing a Glossary definition of *effective dose* or "ED", as had been suggested by the TPPT July 2013 meeting, and which had been reviewed by the TPG in 2014 with the conclusion that it was not possible to develop a definition because a dose is normally a quantity, but is expressed here as a level of efficacy. The SC May 2014 tasked the TPPT to work further on the issue[36].

[125] It was noted that an effective dose (as included in ISPM 28:2007) was intended to represent the level of effect provided by the treatment schedule in achieving the intended efficacy in a population of target pests at a given level of confidence (e.g. 95%).

[126] The TPPT discussed the options proposed by the TPG and agreed that defining a "dose" as an "effect" was illogical. The problem arises because originally ED (or LD) would be calculated by using a range of doses, measuring the effect and then interpolating the dose that was estimated to produce a specific effect (e.g. LD_{50}, LD_{99} etc.).

[127] A treatment schedule needs to represent the *efficacy* (at a confidence level) which is achieved by the treatment when applied according to the treatment schedule which includes a stated treatment *dose*.

[33] 15_TPPT_2014_Jun

[34] 19_TPPT_2014_Jun

[35] 20_TPPT_2014_Jun

[36] 16_TPPT_2014_Jun

[128] Another problem related to the use of the terms *reliability* and *confidence*. These terms are used interchangeably in some texts and create confusion when used together. The TPPT recommended that the term *effect* be used rather than *reliability* to lessen this confusion.

[129] The panel discussed various options on how to deal with the confusion related to the (lack of or possibly illogical) definition. Some found that *dose effect* would be a more suitable term. In that case the subscript may not be appropriate (it should be "dose effect at 150 Gy", etc). If this would be the term used, the TPPT did not feel there would be a need for defining the term, as it is generally used and understood.

[130] Other members found that *effective dose* or *dose effect* should not be used at all, but rather that the text in the schedules should be modified to state that "the dose has been calculated to have a minimum efficacy level of…….% at the 95% confidence level".

[131] In both above cases, ink amendments would need to be introduced to ISPM 28:2007 and annexes.

[132] Others considered that it may be best to continue using *effective dose* and the following definition that avoids defining a dose as an effect and also addresses the confusion between *reliability* and *confidence* was proposed:

Effective dose (ED)	The level of effect at a specified level of confidence that is provided by a treatment dose when applied in accordance with the treatment schedule. The treatment would therefore be presented in the following manner: Treatment Dose (XXX units) ($ED_{[level\ of\ effect]}$ at the *[% level of confidence]* level of confidence) (e.g. 150 Gy ($ED_{99.9963}$ at the 95% level of confidence))

[133] The TPPT considered whether to define '***level of effect***' and proposed the following text to be added to the definition, should the TPG find it appropriate:

The level of effect is the ratio of target organisms (or organism life stage) that achieve the stated treatment outcome at the given level of confidence.

[134] The TPPT further discussed how the term is used in the other official FAO languages, and determined that the term is used in the same way as in English.

[135] The TPPT did not agree on a way forward but decided that the lead should elaborate on the options envisaged, and that the TPPT will discuss the issue again in a virtual meeting.

[136] The TPPT:

(15) *asked* the lead to elaborate on the options for the definition for *effective dose (ED)* envisaged in the above discussions and prepare a revised version of the paper to be presented in a virtual meeting.

(16) *invited* the SC to note that *effective dose* is used the same way in all FAO official languages.

10. Other Business

[137] The TPPT discussed which treatments may be more used in the future, and they agreed that this was difficult to say at this point.

10.1 Virtual Tools

[138] The Secretariat demonstrated how the TPPT forum on the IPP (www.ippc.int) works[37] and introduced the Virtual meeting tools that the Secretariat uses for the TPPT virtual meetings[38].

11. Follow-up Actions for Next TPPT Meeting

11.1 Review of List of Topics (treatment leads and vacancies, prioritization, etc.)

[139] The Secretariat introduced the treatments and standards currently on the *List of topics for IPPC standards* and TPPT reviewed it as regards the SC modifications to stewards and assistant stewards, vacancies and prioritizations[39] and proposed additional modifications.

[140] The TPPT:

(17) *invited* the SC to consider the proposed modifications to stewards and assistant stewards to the topics and subjects on the TPPT work programme.

11.2 TPPT Work Programme

[141] The TPPT reviewed the work programme as developed in the meeting (Appendix 6).

11.3 Call for experts

[142] Three TPPT members will end their second term in 2015. The TPPT invited the panel members in question to confirm availability to remain another term. Should their NPPO or RPPO not be able to confirm the availability, calls will be prepared to replace them. Additionally, a call for experts will be made to fill the current two vacant positions on the panel.

12. Recommendations to the SC

(1) considering the need for alternative treatments to methyl bromide fumigation treatments, the outcomes from the Expert Consultation on Cold Treatments and the current TPPT work programme, *invited* the SC to consider issuing a call for treatments in 2015.

(2) *invited* SC to note that the TPPT selected Mr Guy HALLMAN (USA) to act as liaison between the TPPT and the Phytosanitary Temperature Treatments Expert Group (PTTEG) to exchange information on the research of temperature treatments to help support the development of international phytosanitary treatments.

(3) *invited* the SC to approve the position papers developed over the years, namely:

a. Most thermotolerant stage of Tephritidae

b. Presence of live adult insects after irradiation phytosanitary treatment

(4) *recommended* the cold treatments as modified in this meeting for: *Bactrocera tryoni* on *Citrus sinensis* (2007-206E); *Bactrocera tryoni* on *Citrus reticulata* × *C. sinensis* (2007-206F); *Bactrocera tryoni* on *Citrus limon* (2007-206G) to the SC for adoption by the CPM.

(5) *invited* the SC to review the TPPT responses to the formal objections on cold treatments received before CPM-9 (2014) for their endorsement as appropriate.

(6) *invited* the SC to remind contracting parties that there is no obligation for a contracting party to approve, register or implement the IPPC phytosanitary treatments for use in its territory and consider adding this as a note in the response to the formal objections.

(7) *invited* the SC to consider the possibility of amending phytosanitary treatments, amendments to be submitted through the normal standard setting procedure, to include additional schedules as data become available.

[37] TPPT Forum page: https://www.ippc.int/forums/tppt-discussions

[38] IPPC virtual meeting tools: https://www.ippc.int/core-activities/standards-setting/virtual-tools

[39] 13_TPPT_2014_Jun

(8) *recommended* the Irradiation treatment for *Dysmicoccus neobrevipes*, *Planococcus lilacinus* and *Planococcus minor* (2012-011) to the SC for submission to the CPM for adoption.

(9) *recommended* the draft PT for *Sulfuryl fluoride fumigation of insects in debarked wood* (2007-101A) as modified in this meeting to the SC for member consultation.

(10) *recommended* the draft PT for *Sulfuryl fluoride fumigation of nematodes and insects in debarked wood* (2007-101B) as modified in this meeting to the SC for member consultation.

(11) *recommended* the draft *Heat treatment of wood using dielectric heating* (2007-114) as modified in this meeting to the SC for member consultation.

(12) *recommended* the draft Vapour heat treatment for *Bactrocera tryoni* on *Mangifera indica* (2010-107) to the SC for member consultation.

(13) *invited* the SC to note that *effective dose* is used the same way in all FAO official languages.

(14) *invited* the SC to consider the proposed modifications to stewards and assistant stewards to the topics and subjects on the TPPT work programme.

13. Close of the meeting

[143] The next TPPT face-to-face meeting is tentatively scheduled for 26-30 October 2015, Tohoku, Japan, and participants were reminded to check the IPP calendar for updated information. Some TPPT members were concerned that they would not be able to make these dates and the Secretariat will initiate a forum discussion to decide on this.

[144] The following virtual meetings are currently scheduled (all dates are tentative):

- 23 Sep 2014
- 16 Dec 2014
- 24 March 2015
- 25 June 2015
- 25 September 2015

Evaluation of the meeting process

[145] The Chair asked participants to fill out the evaluation form[40] and submit them to the Secretariat for the future improvement of TPPT meetings.

Adoption of the report

[146] As a usual practice the TPPT will have a forum discussion to adopt the report. The forum discussion is tentatively scheduled for two weeks from 4 July 2014.

Close

[147] The Chair thanked the participants for their excellent work during the meeting and expressed deep gratitude to the host for an impeccable organization and the logistical arrangements and for their exceeding hospitality.

[40] 12_TPPT_2014_Jun

Appendix 1: Agenda

AGENDA ITEM	DOCUMENT NO.	PRESENTER
1. Opening of the Meeting		IPPC SECRETARIAT
• Welcome by the IPPC Secretariat • Election of the Chair • Election of the Rapporteur • Adoption of the Agenda	01_TPPT_2014_Jun Rev2	SHAMILOV CHAIR
2. Administrative Matters		CHAIR
• Documents List • Participants List • Local Information	02_TPPT_2014_Jun Rev1 03_TPPT_2014_Jun Rev1 04_TPPT_2014_Jun Rev2	SHAMILOV
3. Updates from Relevant Bodies		CHAIR
3.1 2014 May Standards Committee • SC review of the TPPT activities • SC review of the List of Topics for IPPC Standards • Draft specifications presented to SC for new topics added to the *List of topics for IPPC standards* by CPM-9 (2014) • SC request to TPPT to review of the TPPT criteria for treatment evaluation • SC review of the TPPT Position papers • SC comments on the Formal objections received prior to CPM-9 (2014)[41] • IRSS on the implementation of ISPM 18:2003 • TPPT midterm focus on treatment requirements • Collaboration between TPPT and PTTEG • Other SC decisions in regards with the TPPT	05_TPPT_2014_Jun Rev1	SHAMILOV
3.2 IPPC Secretariat • Status of Phytosanitary treatments under the TPPT work programme • TPPT Lead and Support	06_TPPT_2014_Jun	SHAMILOV
4. Review Cold Treatments	07_TPPT_2014_Jun 08_TPPT_2014_Jun 22_TPPT_2014_Jun	CHAIR
4.1 Cold treatment for *Ceratitis capitata* on *Citrus sinensis* (2007-206A)	2007-206A_Draft Treatment 2007-206A_Treatment Portfolio	WILLINK
4.2 Cold treatment for *Ceratitis capitata* on *Citrus reticulata* × *C. sinensis* (2007-206B)	2007-206B_Draft Treatment 2007-206B_Treatment Portfolio	GOMES

[41] CPM 2014/INF/05

AGENDA ITEM	DOCUMENT NO.	PRESENTER
4.3 Cold treatment for *Ceratitis capitata* on *Citrus limon* (2007-206C)	2007-206C_Draft Treatment 2007-206C_Treatment Portfolio	WANG
4.4 Cold treatment for *Bactrocera tryoni* on *Citrus sinensis* (2007-206E)	2007-206E_Draft Treatment 2007-206E_Treatment Portfolio	WILLINK
4.5 Cold treatment for *Bactrocera tryoni* on *Citrus reticulata* x *C. sinensis* (2007-206F)	2007-206F_Draft Treatment 2007-206F_Treatment Portfolio	WILLINK
4.6 Cold treatment for *Bactocera tryoni* on *Citrus limon* (2007-206G)	2007-206G_Draft Treatment 2007-206G_Treatment Portfolio	WANG
4.7 Cold treatment for *Ceratitis capitata* on *Citrus paradisi* (2007-210)	2007-210_Draft Treatment 2007-210_Treatment Portfolio	GOMES
4.8 Cold treatment for *Ceratitis capitata* on *Citrus reticulata* cultivars and hybrids (2007-212)	2007-212_Draft Treatment 2007-212_Treatment Portfolio 2007-212_Reference_Argentina	ORMSBY
5. Review of Irradiation Treatment		CHAIR
5.1 Irradiation *for Dysmicoccus neobrevipes Planococcus lilacinus* and *Planococcus minor* (2012-011)	09_TPPT_2014_Jun 10_TPPT_2014_Jun 2012-011_Draft Treatment 2012-011_TreatmentPortfolio	PARKER/ HALLMAN
6. Review of Wood Treatments		CHAIR
6.1 Sulfuryl fluoride fumigation of wood packaging material (2007-101)	2007-101_Submitter Response 2013 2007-101 Updated Checklist 2007-101_Draft Treatment 2007-101_TreatmentPortfolio	ORMSBY
6.2 Heat treatment of wood using dielectric heating (2007-114)	2007-114_Additional Reference 2007-114 Updated Checklist 2007-114_Draft Treatment 2007-114_TreatmentPortfolio	ORMSBY
7. Review of Issues Relating to Vapour Heat Treatments		CHAIR
7.1 Characterization of heated air treatments	11_TPPT_2014_Jun	HALLMAN/ JESSUP/ MYERS
7.2 TPPT Recommendations for future research on HTFA treatment	14_TPPT_2014_Jun	JESSUP
8. Review of Vapour Heat Treatments		CHAIR
8.1 Vapour heat treatment for *Mangifera indica* var. Manila Super (2009-108)	2009-108_TreatmentPortfolio	WILLINK/ SHAMILOV
8.2 Vapour heat treatment for *Bactrocera tryoni* on *Mangifera indica* (2010-107)	2010-107_Submitter Response 2014 2010-107 Updated Checklist 2010-107_Draft Treatment 2010-107_TreatmentPortfolio	HALLMAN
9. Other Items from TPPT Work Programme		CHAIR

AGENDA ITEM	DOCUMENT NO.	PRESENTER
9.1 The concept and possible content of requirements for the use of phytosanitary treatments • Draft (generic) Specification for ISPMs: Requirements for the use of phytosanitary treatments as phytosanitary measures (2014-008) • Requirements for the use of fumigation treatments • Requirements for the use of temperature treatments • Requirements for the use of irradiation • Requirements for the use of modified atmosphere treatments • Requirements for the use of chemicals treatments	23_TPPT_2014_Jun 17_TPPT_2014_Jun 18_TPPT_2014_Jun 21_TPPT_2014_Jun XX_TPPT_2014_Jun XX_TPPT_2014_Jun	ALL
9.2 Working TPPT criteria for treatment evaluation	24_TPPT_2014_Jun	GOMES
9.3 Instruction to assist NPPOs and RPPOs in proper and complete submissions	15_TPPT_2014_Jun 19_TPPT_2014_Jun 20_TPPT_2014_Jun	ORMSBY
9.4 Technical Support Document for Glossary Definition of Effective Dose	16_TPPT_2014_Jun	ORMSBY
10. Other Business		CHAIR
10.1 Virtual Tools • TPPT forums on IPP (www.ippc.int) • Virtual meeting participation	TPPT Forum page Virtual tools on IPP	SHAMILOV
11. Follow-up Actions for Next TPPT Meeting		CHAIR
11.1 Review of List of Topics (treatment leads and vacancies, prioritization, etc.)	13_TPPT_2014_Jun	SHAMILOV
11.2 TPPT Work Programme	To be developed at the meeting	NIYAZI
11.3 Call for experts	Calls page on IPP	SHAMILOV
12. Recommendations to the Standards Committee		CHAIR
13. Closure of the Meeting		CHAIR
• Date and venue of the next TPPT meeting • Date and number of further virtual meetings • Evaluation of the meeting process • Adoption of the report • Close	Calendar on IPP 12_TPPT_2014_Jun	SHAMILOV

Appendix 2: Documents List

DOCUMENT NO.	AGENDA ITEM	DOCUMENT TITLE	DATE POSTED / DISTRIBUTED
Draft treatments, portfolios, checklists and references			
2007-206A	4.1	Draft Treatment	2014-05-24
2007-206A	4.1	Treatment Portfolio	2014-05-24
2007-206B	4.2	Draft Treatment	2014-05-24
2007-206B	4.2	Treatment Portfolio	2014-05-24
2007-206C	4.3	Draft Treatment	2014-05-24
2007-206C	4.3	Treatment Portfolio	2014-05-24
2007-206E	4.4	Draft Treatment	2014-05-24
2007-206E	4.4	Treatment Portfolio	2014-05-24
2007-206F	4.5	Draft Treatment	2014-05-24
2007-206F	4.5	Treatment Portfolio	2014-05-24
2007-206G	4.6	Draft Treatment	2014-05-24
2007-206G	4.6	Treatment Portfolio	2014-05-24
2007-210	4.7	Draft Treatment	2014-05-24
2007-210	4.7	Treatment Portfolio	2014-05-24
2007-212	4.8	Draft Treatment	2014-05-24
2007-212	4.8	Treatment Portfolio	2014-06-05
2007-212	4.8	Reference Argentina CT	2014-06-05
2012-011	5.1	Draft Treatment	2014-05-24
2012-011	5.1	Treatment Portfolio	2014-05-24
2007-101	6.1	Draft Treatment	2014-05-24
2007-101	6.1	Treatment Portfolio	2014-05-24
2007-101	6.2	Submitter response 2013	2014-05-24
2007-101	6.2	Updated Checklist	2014-06-06
2007-114	6.2	Draft Treatment	2014-06-06
2007-114	6.2	Treatment Portfolio	2014-06-06
2007-114	6.2	Updated Checklist	2014-06-06
2007-114	6.2	Additional reference	2014-06-06
2009-108	8.1	Treatment Portfolio	2014-05-24
2010-107	8.2	Draft Treatment	2014-05-24

DOCUMENT NO.	AGENDA ITEM	DOCUMENT TITLE	DATE POSTED / DISTRIBUTED
2010-107	8.2	Treatment Portfolio	2014-05-24
2010-107	8.2	Updated Checklist	2014-06-05
2010-107	8.2	Submitter response 2014	2014-05-24
Other working papers			
01_TPPT_2014_Jun_Rev2	1.0	Agenda	2014-06-16
02_TPPT_2014_Jun_Rev1	2.0	Document List	2014-06-16
03_TPPT_2014_Jun_Rev1	2.0	Participants List	2014-06-05
04_TPPT_2014_Jun_Rev2	2.0	Local Information	2014-05-13
05_TPPT_2014_Jun_Rev1	3.1	Update from SC 2014 May	2014-06-05
06_TPPT_2014_Jun	3.2	Update from IPPC Secretariat	2014-06-05
07_TPPT_2014_Jun	4.0-4.8	Formal objections to draft ISPMs presented for adoption to CPM-9 (2014)	2014-05-24
08_TPPT_2014_Jun	4.0-4.8	TPPT response to Formal Objections	2014-06-05
09_TPPT_2014_Jun	5.1	TPG recommendations - 2012-011: Draft Annex to ISPM 28:2007: Irradiation	2014-05-24
10_TPPT_2014_Jun	5.1	Treatment Lead response to Member Comments	2014-05-24
11_TPPT_2014_Jun	7.1	Characterization of Heated Air Treatments	2014-06-05
12_TPPT_2014_Jun	13	Meeting Evaluation Form	2014-05-24
13_TPPT_2014_Jun	11.1	Extract from LOT for IPPC standards	2014-05-24
14_TPPT_2014_Jun	7.2	TPPT Recommendations for future research on HTFA treatment	2014-06-05
15_TPPT_2014_Jun	9.3	Instructions to assist proper and complete submissions	2014-06-05
16_TPPT_2014_Jun	9.4	Technical support document for Glossary Definition of Effective Dose	2014-06-05
17_TPPT_2014_Jun	9.1	Requirements for the use of fumigation as a phytosanitary measure	2014-06-16
18_TPPT_2014_Jun	9.1	Requirements for the use of temperature treatments as a phytosanitary measure	2014-06-05
19_TPPT_2014_Jun	9.3	Reference on Research Statistics	2014-06-05
20_TPPT_2014_Jun	9.3	Reference on Methyl bromide fumigation	2014-06-05
21_TPPT_2014_Jun	9.1	Requirements for the use of irradiation as a phytosanitary measure	2014-06-16
22_TPPT_2014_Jun	4.0	Reference Japan Cold Treatments GF	2014-06-16
23_TPPT_2014_Jun	9.1	Draft (generic) Specification for ISPMs: Requirements for the use of phytosanitary treatments as phytosanitary measures (2014-008)	2014-06-16
24_TPPT_2014_Jun	9.2	Working TPPT criteria for treatment evaluation	2014-06-27

LINKS:	Agenda item	Content
TPPT forums on IPP (www.ippc.int)	10.1	TPPT Forum page
Virtual meeting participation	10.1	Virtual tools on IPP
Call for experts	11.3	Calls page on IPP
Date and venue of the next TPPT meeting	13	Calendar on IPP

Appendix 3: Participants List

Participant role	Name, mailing, address, telephone	Email address	Term expires
Steward	**Mr Jan Bart ROSSEL** Director International Plant Health Program Office of the Australia Chief Plant Protection Officer Australian Government Department of Agriculture **AUSTRALIA** Tel: +61 2 6272 5056 / 0408625413	bart.rossel@agriculture.gov.au	NA
Member	**Mr Patrick GOMES** Fruit Fly Coordinator Science & Technology USDA APHIS PPQ 1730 Varsity Drive Suite 400 Raleigh, North Carolina 27606 **USA** Tel: (919) 855-7313 / (919) 625-7660	Patrick.J.Gomes@aphis.usda.gov	2017 – 1st Term
Member	**Mr Guy HALLMAN** Research Entomologist Stored Product Insect Research Unit Center for Grain & Animal Health Research 1515 College Ave. Manhattan, KS 66502 **USA** Tel: +1 956 457 5559	Guy.Hallman@ars.usda.gov	2017 – 1st Term
Member	**Mr Andrew JESSUP** Senior Research Horticulturist NSW Department of Primary Industries Locked Bag 26, GOSFORD NSW 2250 **AUSTRALIA** Tel: +02 4348 1965	andrew.jessup@dpi.nsw.gov.au	2014 – 1st Term 2019 – 2nd Term
Member	**Mr Michael ORMSBY** Senior Adviser, Plant Risk Analysis Ministry for Primary Industries P.O Box 2526, Wellington, **NEW ZEALAND** Tel: +64 4 8940486	Michael.Ormsby@mpi.govt.nz;	2015 – 2nd Term

Participant role	Name, mailing, address, telephone	Email address	Term expires
Member	**Mr Eduardo WILLINK** Estación Experimental Agroindustrial Obispo Colombres, P.O.Box 9, Las Talitas (4101) Tucumán **ARGENTINA** Tel: +54 381-4521010; +54 381-154692512	ewillink@eeaoc.org.ar ewillink@arnet.com.ar	2015 – 2nd Term
Member	**Mr Yuejin WANG** Institute of Inspection Technology and Equipment Chinese Academy of Inspection and Quarantine No. 241 Huixinli, Chaoyang District, Beijing 100029 **CHINA** Tel: +86 10 64934647	wangyuejin@263.net.cn	2015 – 2nd Term
Member	**Mr Scott MYERS** USDA APHIS Entomologist / Commodity Treatment Specialist 1398 W Truck Rd., Buzzards Bay, MA, **USA** Tel: 508-563-0959	scott.w.myers@aphis.usda.gov	2018– 1st Term
Invited Expert	**Mr Andrew PARKER** Insect Pest Control Laboratory FAO/IAEA Agriculture and Biotechnology Laboratories Agency's Laboratories Seibersdorf IAEA A-2444 Seibersdorf **AUSTRIA** Tel: +43 1 2600 28408	a.parker@iaea.org	NA
IPPC Secretariat Lead	**Mr Artur SHAMILOV** International Plant Protection Convention Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla 00153 Rome **ITALY** Tel: + 39 06 570 56 073	Artur.Shamilov@fao.org	NA

Participant role	Name, mailing, address, telephone	Email address	Term expires
IPPC Secretariat Support	**Mr Nuri NIYAZI** International Plant Protection Convention Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla 00153 Rome **ITALY** Tel: + 39 06 570 55020	Nuri.Niyazi@fao.org	NA
IPPC Secretariat Support	**Ms Eva MOLLER** International Plant Protection Convention Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla 00153 Rome, **ITALY** Tel: +39 06 570 52 855	Eva.Moller@fao.org	NA
Host (NPPO Indonesia)	**Mr Antarjo DIKIN** Center for Plant Quarantine and Biosafety, Indonesian Agricultural Quarantine Agency Jalan Harsono RM No. 3 Jakarta, 12550 INDOESIA Tel: +62 21 7816482	antarjo.dikin@yahoo.com	NA
Host (NPPO Indonesia)	**Mr HERMAWAN** Center for Plant Quarantine and Biosafety, Indonesian Agricultural Quarantine Agency Jalan Harsono RM No. 3 Jakarta, 12550 INDONESIA Tel: +62 21 7816482	hermawan1961@gmail.com	NA

Appendix 4: Treatment evaluations

TPPT evaluation of Irradiation Treatment for *Dysmicoccus neobrevipes*, *Planococcus lilacinus* and *Planococcus minor* (2012-011)

Treatment lead: Mr Andrew Parker

The treatment lead informed the panel that all the comments from the member consultation had been noted and appropriate changes made to the draft. Only two comments of a substantive nature were received and these were addressed by adopting wording proposed by the USA. The comments of TPG were also noted and all changes proposed by TPG accepted. The panel noted the changes made to the draft and recommends to SC that the draft be forwarded for adoption.

For further information regarding this evaluation, please contact a.parker@iaea.org

TPPT evaluation of Heat Treatment of Wood Using Dielectric Heating (2007-114)

Treatment lead: Mr Michael Ormsby

The TPPT first evaluated this treatment in July 2007 and considered that a treatment using dielectric heating (microwaves) is a type of heat treatment. As such the panel considered the large volume of published papers, commercial reports and experience with years of use supported the conclusion that a heat treatment was effective against most invertebrate forestry pests likely to be associated with wood packaging material. This conclusion was further supported by the (draft) publication of a report on the general effectiveness of heat treatment against wood borne pests (NAPPO 2013).

The panel concluded that as available research had established that all life stages of *Anoplophora glabripennis* (Asian longhorn beetle) were significantly less tolerant to heat treatment than *Bursaphelenchus xylophilus* (Pinewood nematode) (Fleming *et al.* 2003, 2004), the submitter needed to demonstrate that the heat treatment was at least 99.99683% effective against *Bursaphelenchus xylophilus* (Pinewood nematode) only (at the 95% level of confidence).

In response to the request for further information the submitter:

- provided sufficient evidence that the heat treatment was at least 99.99683% effective against *Bursaphelenchus xylophilus* (Pinewood nematode) (Hoover *et al.* 2010; Tomminen *et al.* 1991, 1992);
- confirmed that combustion can only occur if wood lacking any free water (completely dehydrated) were to exceed temperatures of 270-300^{O}C;
- confirmed that heating-up time had an effect on treatment efficacy but that the efficacy was not overly sensitive to this factor. The TPPT therefore concluded no maximum heating up time needed to be included in the treatment schedule.

A subsequent further review of available literature by the panel identified that:

- dielectric heating offers an advantage over conventional heating for insect control due to the selective heating of insects (Nelson 1996; Wang *et al*. 2003; Henin *et al.* 2008);
- radio frequency dielectric heating can penetrate beyond the 20 cm limit imposed on the dielectric heating schedule approved in ISPM-15 in 2012 (Janowiak *et al.* 2014). The TPPT considered that authorising NPPOs would need to ensure that treatment facilities achieved the heating requirements throughout the profile of the wood regardless of the size or initial temperature of the wood;
- dielectric heating is a practical method to treat wood in international trade (ISPM 15).

Referenced publications or reports:

Fleming, M., Hoover, K., Janowiak, J., Fang, Y., Wang, X., Liu, W., Wang, Y., Hang, X., Agrawal, D., Mastro, V. & Roy, R. 2003. Microwave irradiation of solid wood packing material (pallet and crate lumber): An effective technique to destroy the Asian longhorned beetle (*Anoplophora glabripennis*) hitchhiking to the United States. Forest Products Journal, 52: 1–7.

Fleming, M.R., Janowiak, J.J., Kearns, J., Shield, J.E., Roy, R., Agrawal, D.K., Bauer, L.S., Miller, D.L. & Hoover, K. 2004. Parameters for scale-up of microwave treatment to eradicate cerambycid larvae infesting solid wood packing materials. Forest Products Journal, 54 (7/8): 80–84.

Henin, J.-M., Charron, S., Luypaert, P.J., Jourez, B. & Hebert, J. 2008. Strategy to control the effectiveness of microwave treatment of wood in the framework of the implementation of ISPM 15. Forest Products Journal, 58: 75–81.

Hoover, K., Uzunovic, A., Gething, B., Dale, A., Leung, K., Ostiguy, N. & Janowiak, J.J. 2010. Lethal temperature for pinewood nematode, *Bursaphelenchus xylophilus*, in infested wood using microwave energy. Journal of Nematology, 42 (2): 101-110.

Janowiak, J., Dubey, M., Hoover, K., Mack, R., Elder, P. (2014) Comparative study of radio frequency (RF) and microwave (MW) heating of wood in compliance with ISPM-15 phytosanitary treatment.

NAPPO (2013) Draft ST 03: Review of heat treatment of wood and wood packaging. NAPPO Forestry Panel.

Nelson, S. O. **1996**. Review & assessment of microwave energy for stored-grain insect control. *American Society of Agricultural Engineers*, 39(4):1475–84

Tomminen, J., Halik, S. & Bergdahl, D.R. 1991. Incubation temperature and time effects on life stages of *Bursaphelenchus xylophilus* in wood chips. Journal of Nematology, 23: 477–484.

Tomminen, J. & Nuorteva, M. 1992. Pinewood nematode, *Bursaphelenchus xylophilus* in commercial sawn wood and its control by kiln-heating. Scandinavian *Journal of Forest Research* 7: 113–120.

Wang, S., J. Tang, J.A. Johnson, E. Mitcham, J.D. Hansen, G. Hallman, S.R. Drake, and Y. Wang 2003. Dielectric Properties of Fruits and Insect Pests as Related to Radio Frequency and Microwave Treatments. Biosystems Engineering 85(2): 201–12.

For further information regarding this evaluation, please contact Michael.Ormsby@mpi.govt.nz

TPPT evaluation of Sulfuryl fluoride fumigation of wood packaging material (2007-101)

Treatment lead: Mr Michael Ormsby

A considerable amount of literature was reviewed in the evaluation of research supporting the efficacy of SF fumigation on insect pests of wood. Table 1 provides a summary of the species of insects exposed to SF fumigation from these reviewed literature.

Table 1: Insect species tested for tolerance to SF fumigation

Pest species	Taxonomy	Life stage (most resistant tested)	Minimum CT (g-h/ m^3) (0 survs.)	Estimated ED	Reference
Anobium punctatum	Anobiidae	Eggs	2586 (17°C)	99.7462	Binker *et al*. 1999

Lasioderma serricorne	Anobiidae	Eggs	2000 (27°C)	99%	Su *et al*. 1990
Attagenus megatoma	Anobiidae	Eggs	2000 (27°C)	99%	Su *et al*. 1990
Anthrenus flavipes	Anobiidae	Eggs	2000 (27°C)	99%	Su *et al*. 1990
Dermestes maculatus	Anobiidae	Eggs	2000 (27°C)	99%	Su *et al*. 1990
Euvrilletta peltata	Anobiidae	All Life Stages	?	?	William *et al* 1990
Lyctus brunneus	Lyctidae	All Life Stages	?	?	William *et al* 1990
Agrilus planipennis	Buprestidae	Eggs	Dose response	99.95	Barak *et al*. 2010
Anoplophora glabipennis	Cerambycidae	Larvae, Pupae	Dose response	Probit 9	Barak *et al*. 2006
Hylotrupes bajulus	Cerambycidae	Eggs (4 day old))	2575 (22°C)	Not established	Verheyen 2002
Hylotrupes bajulus	Cerambycidae	Eggs (3 day old))	2500 (20°C)	100%?	Ducom *et al*. 2003
Semanotus japonicus	Cerambycidae	All Life Stages	Dose response	LD 95	Soma *et al*. 1996 Soma *et al*. 1997
Callidiellum rufipenne	Cerambycidae	All Life Stages	Dose response	LD 95	Soma *et al*. 1996 Soma *et al*. 1997
Monochamus alternatus	Cerambycidae	All Life Stages	Dose response	LD 95	Soma *et al*. 1996 Soma *et al*. 1997
Arhopalus tristis	Cerambycidae	Eggs	2083 (15°C)	99	Zhang 2006
Ips cembrae	Curculionidae	Eggs	480 (25°C)	LD 95	Soma *et al*. 1996 Soma *et al*. 1997
Pissodes nitidus	Curculionidae	Larvae	720 (25°C)	LD 95	Soma *et al*. 1997
Cryphalus fulvus	Scolytidae	Eggs	480 (25°C)	LD 95	Soma *et al*. 1996 Soma *et al*. 1997
Phloeosinus perlatus	Scolytidae	Eggs	480 (25°C)	LD 95	Soma *et al*. 1996 Soma *et al*. 1997
Hylastes alter	Scolytidae	Larvae	260 (15°C)	92.8	Zhang 2006
Xylosandrus germanus	Scolytidae	All Life Stages	Dose response	LD 95	Mizobuchi *et al*. 1996; Soma *et al*. 1997
Xyloborus validus	Scolytidae	All Life Stages	Dose response	LD 95	Mizobuchi *et al*. 1996; Soma *et al*. 1997
Xyloborus pfeili	Scolytidae	All Life Stages	Dose response	LD 95	Mizobuchi *et al*. 1996; Soma *et al*. 1997
Platypus calamus	Platypodidae	All Life Stages	Dose response	LD 95	Mizobuchi *et al*. 1996; Soma *et al*. 1997
Platypus quercivorus	Platypodidae	All Life Stages	Dose response	LD 95	Mizobuchi *et al*. 1996; Soma *et al*. 1997
Cryptotermes cavifrons	Kalotermitidae	Larvae	40.3 (27°C)	LD 99	Osbrink et al. 1987
Kalotermes approximates	Kalotermitidae	Larvae	65.1 (27°C)	LD 99	Osbrink et al. 1987
Incisitermes minor	Kalotermitidae	Larvae	66.2 (27°C)	LD 99	Osbrink *et al*. 1987
Incisitermes snyderi	Kalotermitidae	Larvae	55.2 (27°C)	LD 99	Osbrink *et al*. 1987
Neotermes jouteli	Kalotermitidae	Larvae	43 (27°C)	LD 99	Osbrink *et al*. 1987
Coptotermes formosanus	Rhinotermitidae	Larvae	42.5 (27°C)	LD 99	Osbrink *et al*. 1987
Coptotermes formosanus	Rhinotermitidae	Adults	60 (27°C)	LD 99	Su *et al*. 1989
Coptotermes formosanus	Rhinotermitidae	Adults & Larvae	50 (20°C)	LD 50	La Fage *et al*. 1982

The panel noted that the species tested covered many of the pest groups of concern on wood moved in

international trade as identified in the draft ISPM for Wood (see Table 2).

Table 2. Insect pest groups of potential quarantine concern associated with the international movement of wood commodities.

Pest group	Examples within the pest group
Bark beetles	Scolytinae
Wood flies	Pantophthalmidae
Wood-boring beetles	Cerambycidae, Curculionidae, Buprestidae
Wood moths	Cossidae
Wood wasps	Siricidae
Powder post beetles	Anobiidae, Bostrichidae
Termites and carpenter ants	Rhinotermitidae, Kalotermidae, Formicidae
Moths	Lymantriidae
Aphids, adelgids	Adelgidae
Scales	Diaspididae

From the list of insect pests tested for tolerance to SF fumigation, the panel identified three that had confirmatory trials supporting the level of stated efficacy at the 95% level of confidence. The life stages tested were those likely to be found in debarked wood in international trade.

- *Anoplophora glabripennis* (larvae and pupae) $ED_{99.99683}$
- *Anobium punctatum* (all life stages) $ED_{99.7462}$
- *Arhopalus tristis* (all life stages) ED_{99}

The panel considered that member countries may choose to accept SF fumigation as an effective treatment for all insects and life stages found in wood.

SF fumigation for nematode pests

In the context of wood pests, only pine wood nematode (PWN) (*Bursaphelenchus xylophilus*) is considered to be a potential pest of concern on wood moving in international trade. A number of authors have tested the effectiveness of SF fumigation against PWN in wood (Soma 2001, Dwinell *et al.* 2005, Sousa *et al.* 2010, Sousa *et al.* 2013). In discussions with the International Forest Quarantine Research Group (IFQRG) and the Technical Panel for Forest Quarantine (TPFQ) the groups agreed that when testing treatment efficacy against PWN, by exposing large (+1 million) populations of PWN all of the life stages found in wood would be exposed in sufficient numbers to demonstrate adequate levels of efficacy.

In full confirmatory trials presented by Sousa *et al.* 2010, SF fumigation schedules for ~15^{O}C and 30^{O}C had no survivors from the high number of exposed nematodes. Treatments at 20^{O}C however did have survivors at all doses applied. On request from the TPPT confirmatory trials were repeated for 20^{O}C by Sousa *et al.* 2013 who identified a schedule that resulted in no survivors. This new schedule required a 48 hour exposure period rather than the 24 hour exposure period required for insects and PWN at ~15^{O}C and 30^{O}C.

The TPPT noted that the schedules for PWN treatment ~15^{O}C, 20^{O}C and 30^{O}C did not follow a sequence that could easily be explained by expected dose/response/temperature relationships. Namely that with increasing temperature the dose of fumigant can be reduced to achieve the equivalent level of pest response (mortality). The TPPT therefore considered that the lower temperature schedule (~15

^{O}C) should not be included and the schedule should be for 20^{O}C or above or 30^{O}C or above.

The panel also noted that the treatment schedule for PWN equals or exceeds the treatment requirements for insects.

SF fumigation on fungal pests

The TPPT noted that while SF fumigation achieved a degree of effectiveness against fungi at dose levels much higher than that required for insects and nematodes, the results were mixed and did not provide a sufficient level of confidence. Therefore the TPPT concluded that currently there were no treatment schedules that could be recommended for fungal wood pests.

SF fumigation schedules

The TPPT considered that two treatment schedules should be recommended to the SC for member consultation: one for insect pests of wood and one for PWN and insect pests of wood.

Further the TPPT considered that these treatment schedules should only be applicable to wood types or conditions that are equivalent to those used in the confirmatory trials. Therefore the TPPT added the following restrictions to the treatment schedule:

- That the wood must be debarked before treatment (treatment is for de-barked wood).
- That the wood must not exceed 20 cm in the smallest dimension
- That the wood moisture content should not exceed 60%.

Referenced publications or reports:

Barak A., Wang Y., Zhan G., Wu Y., Xu L. & Huang Q. **2006**. Sulfuryl fluoride as a quarantine treatment for *Anoplophora glabripennis* (Coleoptera: Cerambycidae) in regulated wood packing material. *Journal of Economic Entomology*, 99(5): 1628–1635.

Barak A.V., Messenger M., Neese P., Thoms E. & Fraser I. **2010**. Sulfuryl Fluoride as a Quarantine Treatment for Emerald Ash Borer (Coleoptera: Buprestidae) in Ash Logs. *Journal of Economic Entomology* 103(3): 603-611;

Binker G., Binker, J., Fröba G., Graf, E. & Lanz, B. **1999**. Laboratory study on *Anobium punctatum*. (Unpublished bioassays, Binker Materialschutz, Germany; listed in "Inclusion of active substances in Annex I to Directive 98/8/EC: Assessment report: Sulfuryl fluoride, PT8", September 2006.)

Bonifacio L., Inácio M. L., Sousa E., Buckley S. & Thoms E. M. **2013**. Complementary studies to validate the proposed fumigation schedules of sulfuryl fluoride for inclusion in ISPM No. 15 for the eradication of pine wood nematode (*Bursaphelenchus xylophilus*) from wood packaging material. Report.

Ducom, P., Roussel, C. & Stefanini, V. **2003**. Efficacy of sulfuryl fluoride on European house borer eggs, *Hylotrupes bajulus* (L.) (Coleoptera: Cerambycida). (Contract research project; listed in "Inclusion of active substances in Annex I to Directive 98/8/EC: Assessment report: Sulfuryl fluoride, PT8", September 2006.)

Dwinell, L.D., Thoms, E. & Prabhakaran, S. **2005**. Sulfuryl fluoride as a quarantine treatment for the pinewood nematode in unseasoned pine. In: *Proceedings of the 2005 Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reduction, San Diego, California, USA.* Available at http://mbao.org/2005/05Proceedings/mbrpro05.html (accessed September 2010).

La Fage, J.P., Jones, M. & Lawrence, T. **1982**. A laboratory evaluation of the fumigant, sulfuryl fluoride (Vikane), against the Formosan termite *Coptotermes formosanus* Shiraki. International Research Group on Wood Protection, Thirteenth Annual Meeting, May 1982. Stockholm, Sweden, IRG Secretariat.

Mizobuchi, M., Matsuoka, I., Soma, Y., Kishino, H., Yabuta, S., Imamura, M., Mizuno, T., Hirose, Y. & Kawakami, F. **1996**. Susceptibility of forest insect pests to sulfuryl fluoride. 2. Ambrosia beetles. *Research Bulletin of the Plant Protection Service Japan*, 32: 77–82.

Osbrink, W.L.A., Scheffrahn, R.H., Su, N-Y. & Rust, M.K. **1987**. Laboratory comparisons of sulfuryl fluoride toxicity and mean time of mortality among ten termite species (Isoptera: Hodotermitidae, Kalotermitidae, Rhinotermitidae). *Journal of Economic Entomology*, 80: 1044–1047.

Soma, Y., Yabuta, S., Mizoguti, M., Kishino, H., Matsuoka, I., Goto, M., Akagawa, T., Ikeda, T. & Kawakami, F. **1996**. Susceptibility of forest insect pests to sulfuryl fluoride. 1. Wood borers and bark beetles. *Research Bulletin of the Plant Protection Service Japan*, 32: 69–76.

Soma, Y., Mizobuchi, M., Oogita, T., Misumi, T., Kishono, H., Akagawa, T. & Kawakami, F. **1997**. Susceptibility of forest insect pests to sulfuryl fluoride. 3. Susceptibility to sulfuryl fluoride at 25C. *Research Bulletin of the Plant Protection Service Japan*, 33: 25–30.

Soma, Y., Naito, H., Misumi, T., Mizobuchi, M., Tsuchiya, Y., Matsuoka, I., Kawakami, F., Hirata, K. & Komatsu, H. **2001**. Effects of some fumigants on pine wood nematode, *Bursaphelenchus xylophilus* infecting wooden packages. 1. Susceptibility of pine wood nematode to methyl bromide, sulfuryl fluoride and methyl isothiocyanate. *Research Bulletin Plant Protection Service Japan*, 37: 19–26.

Sousa, E., Bonifácio, L., Naves, P., Lurdes Silva Inácio, M., Henriques, J., Mota, M., Barbosa, P., Espada, M., Wontner-Smith, T., Cardew, S., Drinkall, M.J., Buckley, S. & Thoms, M.E. **2010**. Studies to validate the proposed fumigation schedules of sulfuryl fluoride for inclusion in ISPM No. 15 for the eradication of pine wood nematode (*Bursaphelenchus xylophilus*) from wood packaging material. Report.

Su, N.Y., Osbrink, W.L.A., Scheffrahn, R.H. **1989.** Concentration-time relationship for fumigant efficacy of sulfuryl fluoride against the Formosan subterranean termite (Isoptera: Rhinotermitidae). *Journal of Economic Entomology* 82: 156-158

Su, N.Y., Scheffrahn, R.H. **1990**. Efficacy of sulfuryl fluoride against four beetle pests of museums (Coleoptera: Dermestidae, Anobiidae). *Journal of Economic Entomology* 83: 879-882.

Verheyen, H. **2002**. Investigatory studies on the ovicidal effect of a fumigant on dry wood insect pests. (Student research project; listed in "Inclusion of active substances in Annex I to Directive 98/8/EC: Assessment report: Sulfuryl fluoride", September 2006.)

Williams, L.H. & Sprenkel, R.J. **1990**. Ovicidal activity of sulfuryl fluoride to anobiid and lyctid beetle eggs of various ages. *Journal of Entomological Science*, 25: 366–375.

Zhang. Z. **2006**.Use of Sulfuryl fluoride as an alternative fumigant to Methyl bromide in export log fumigation. *New Zealand Plant Protection*, 59: 223–227.

For further information regarding this evaluation, please contact Michael.Ormsby@mpi.govt.nz

TPPT evaluation of Vapour Heat Treatment for *Bactrocera tryoni* on *Mangifera indica* (2010-107)

Treatment lead: Mr Guy Hallman

2010-107 Vapour heat treatment proposal submission for *Bactrocera tryoni* on *Mangifera indica*

The vapour heat treatment proposal submission for *Bactrocera tryoni* on *Mangifera indica* is recommended for approval for member consultation because it satisfies requirements to support the treatment. The researchers provided information that substantiates that the egg is the most tolerant stage, and a large number of eggs in mangoes were killed with a very high degree of efficacy: $ED_{99.998}$ at the 95% confidence level. The draft treatment schedule can be readily implemented by industry

without significant damage to the fruit and should result in a negligible risk of the pest successfully following the mango pathway to create an infestation.

For further information regarding this evaluation, please contact Guy.Hallman@ARS.USDA.GOV

Appendix 5: Working TPPT Criteria for Treatment Evaluation

1. Introduction

This document provides a description of the agreed procedure for the evaluation of phytosanitary treatments for inclusion in an International Standard for Phytosanitary Measures (ISPM). The procedures and processes documented here have been agreed to and applied by the Technical Panel for Phytosanitary Treatments (TPPT) for the evaluation of phytosanitary treatments against the requirements of ISPM 28:2007 *Phytosanitary treatments for regulated pests*.
It is important to note that the burden is on the submitter to provide a complete and accurate submission and information in support of their proposed treatment. This includes the appropriate statistical analysis of the research results, including efficacy.

2. Procedure for the production of phytosanitary treatments[42]

2.1 Call for submissions for phytosanitary treatments on topics approved by the CPM

The IPPC Secretariat issues a call for submissions for phytosanitary treatments as approved by the Standards Committee (SC). Phytosanitary treatments are submitted by NPPOs or RPPOs for evaluation as an international standard in response to a call for submissions by the Secretariat.

The "Submission Form for Phytosanitary treatments" should be used by NPPOs or RPPOs to submit information on phytosanitary treatments.

The submission forms are collated by the Secretariat and sent to the Technical Panel on Phytosanitary Treatments (TPPT) for review.

2.2 Evaluation of treatment submissions

The TPPT prioritize submissions for development of phytosanitary treatments, taking into account guidance from the SC and the "*Procedure and criteria for identifying topics for inclusion in the IPPC standard setting work programme*[43]" (adopted by the CPM-3 in 2008) and using the score definitions (see this IPPC procedural manual). The TPPT will also take into account recommendations by other CPM bodies.

Submissions will be evaluated for their suitability as an international treatment by the TPPT in line with guidance provided in ISPM No. 28 (*Phytosanitary treatments for regulated pests*) and Section A. The submitted treatments will be determined to be:

- an acceptable treatment;
- a treatment requiring more information or research in order to evaluate its efficacy; or
- a treatment not accepted for inclusion in ISPM 28:2007.

Acceptable treatments will be recommended to the SC. For treatments requiring more information, or unacceptable treatments, the NPPO or RPPO, with a copy to the contact person for the submission will be notified by the Secretariat and additional information will be requested or the reasons for the rejection will be given. In addition, the submitter of treatments that are being recommended to the SC will be advised accordingly.

Section A: Process for the evaluation of treatment submissions by experts

[42] Approved by the TPPT (August 2005), Annex 1 and noted by the SC (May 2006) paragraph 24, updated and approved and included to Working TPPT criteria for treatment evaluation by TPPT (July 2013), Appendix 5 to the report.

[43] The ICPM-4 (2002) adopted the procedures for identifying topics and priorities for standards. Revised procedures were adopted by the CPM-3 (2008). Modified procedures and criteria for identifying topics for inclusion in the IPPC standard setting work programme were adopted, following consideration of outcomes of a Focus Group (CPM-3 (2008), Paragraph 89.3 and Appendix 8).

One expert for each treatment submission is selected as its "lead" by the TPPT to evaluate the submission;

The lead will review the data to ensure it supports the stated efficacy based on ISPM No. 28 (*Phytosanitary treatments for regulated pests*) and additional instructions from the TPPT if needed;

The lead completes a "checklist" and an "evaluation sheet" developed by the TPPT;

In some cases, for example where more than one submission is received for a particular treatment/commodity/pest combination, the lead may need to resolve differences between data sets and to prevent duplication of near identical treatments;

The lead may be able to accumulate further data to support a treatment submission. Where incomplete submissions are received, leads will liaise with the submitter to help progress the submission;

The treatment is then submitted to the TPPT for assessment.

3. Overview of a Good Research Protocol

A number of authors have published comprehensive guides on what good research methodologies should cover when developing phytosanitary treatments. Hallman and Mangan (1998), Hallman (2000), Heather (2004), and Heather and Hallman (2008) provide comprehensive overviews of sound research protocols, while Sgrillo (2002) provides some background and guidance on quantitative parameters for phytosanitary measures.

From these papers and ISPM 28 it can be surmised that a sound research protocol should ensure that:

- there is an unambiguous description of the target pest and commodity, and the nature of the association of the two in trade and how this relates to the mode of action of the treatment;
- the condition of the target pest, host and environment at the time of testing is equivalent to the likely condition or range of conditions found in trade. For example, laboratory colonies of test pests should be representative of what is most likely to be encountered in trade and should be replenished with wild types periodically;
- the effectiveness of the treatment is tested against the most tolerant life stage or condition of the target pest likely to be found at the time of treatment application in trade;
- for generic treatments, effectiveness of the treatment is tested against the most tolerant species within the target group;
- the treatment outcome is appropriate to the phytosanitary needs of trade; and
- the publication or reporting of the research outcomes is suitably transparent for assessment by regulatory organisations.

The specimens are identified to the species level by a specialist, including detailed information of how the species was determined. Refer to ISPM 8:1998 (section 2.1 Pest records) for further guidance.

With regards to voucher specimens, submitters should ensure to preserve sample specimens in appropriate media for future reference.

When doing replicates or when repeating laboratory trials for comparison in a different location or time, conditions should be as similar as possible on each occasion, such as pests, commodities, load factors, testing equipment, experimental protocols, etc.

the methods used to measure the experimental parameters of the treatment are appropriate and that records are provided with submissions. This may include calibration of equipment and records indicating, over time, temperature ranges, treatment duration (including heat up, cool down and dwell time), dosimetry, etc.

Statistical analyses are completed using the most appropriate methods. Experts in statistics should be consulted.

3.1 Experimental conditions are suitable for international trade

Treatment parameters should be tested to ensure changes in conditions that may be found in international trade do not unexpectedly reduce the effectiveness of the treatment. Evidence should therefore be provided that shows how treatment efficacy may be affected when one or more treatment parameters are altered. Examples to consider include but are not limited to the following:

- **Commodity and/or pest temperature during treatment**: under trading conditions the temperature of the commodity or target pest may vary over the duration of the treatment. The effect of such temperature changes on treatment efficacy should be understood.
- **Commodity and/or pest temperature pre- or post- treatment**: pests may become more tolerant of a treatment if their temperature before the treatment is altered (Jamieson *et al.* (in press)). The rate at which pests are returned to normal temperatures after treatment may alter the effect of the treatment.
- **Water content of commodity**: changes in commodity water content may reduce treatment efficacy (e.g. by reducing treatment penetration or increasing pest tolerance).
- **Commodity density or chemical composition**: the density or chemical composition of the commodity may reduce treatment efficacy (e.g. by reducing treatment penetration of chemical reactivity).
- **Hypoxic or aerobic conditions**: the presence or absence of oxygen may reduce treatment efficacy (e.g. by changing pest metabolic or respiration activity).
- **Commodity packaging**: commodity packaging should be consistent with packaging found in international trade.

3.2 Use of historical records

Historical evidence can be used to support the general effectiveness of a treatment that has been in use for many years. When used to determine the level of treatment efficacy, historical data should be utilized only where there is a statistical basis for determining the level of efficacy, e.g. when efficacy data exist in relation to sampling under operational conditions. In most, if not all, cases it will not be known with any degree of accuracy, how many target pests were present prior to treatment; additionally, the accuracy of the inspection methods to detect the pest(s) at a certain level (or even the confidence with which one could detect an organism) needs to be known. In particular, five specific difficulties were identified in the paper:

- The condition of the target regulated article may vary over time.
- The life stage of the target pest may change over time.
- Environmental conditions critical to treatment efficacy may vary over time.
- The number of live target organisms infesting the regulated article may not be known at the time.
- The number of surviving target organisms post-treatment may not have been determined (with any degree of accuracy).

4. General considerations when calculating the effective dose (ED)

The panel has recommended a number of principles that they should apply when calculating the ED for each treatment at the 95% confidence level, based on the total number of target pests treated. Further information on the calculation of the ED is provided in a publication by Couey and Chew (1986). These agreed principles include:

The level of mortality in the controls must be accounted for when calculating treatment efficacy from counts of dead treated pests. The recorded mortality of treated target pests should be adjusted for

natural mortality recorded in controls e.g. if there is a 10% level of mortality in the control sample, 10% of the deaths in the treated sample should be attributed to causes other than the treatment.

Greater than expected natural mortality levels (in controls) should be treated with care as they may indicate a target pest population under stress. A population under stress may be more susceptible to the treatment than a natural population. If control mortality is high, evidence should be provided that either indicates pest susceptibility to the treatment is no greater than normal populations or that high control mortality reflects normal conditions.

Sample sizes and repetitions should be sufficient to account both for natural variation and achieve significant regressions when extrapolating treatment efficacy. A small number of treatment repetitions can, on analysis, result in statistical errors giving meaningless conclusions (if the SD at 95% is greater than the mean, the lower (worst case) result may be a negative dose e.g. 10 ± 12 gives a range from -2 to 22).

When the population of treated pests is estimated from control pest populations, the estimation must be based on a statistical analysis of the controls. Where possible, control data should not be grouped together, but should be recorded for each individual test commodity or target pest. Pseudo-replication[44] should be avoided or minimized, as much as possible.

Researchers need to apply the same statistical rigour to control data as they do to treatment data. Where the infestation rate for each regulated article in the control is known, the estimated treated regulated article infestation rate would be:

Average per treated regulated article = **μ - (STD × 1.645)**

Where the control infestation rate is based on the mean of grouped commodities, as the number of controls increases so does the level of confidence in the estimation of the population mean. A suitable formula for estimating the average number of exposed pests per treated regulated article would therefore be:

Average per treated regulated article = **μ - (STD × $\sqrt{(1+1/r)}$)**

Note: **r** is equal to the number of control replicates used to estimate the mean (**μ**) and standard deviation (**STD**) of the control means.

5. Choosing Surrogate Species for the Development of Phytosanitary Treatments

Note: In the context of the TPPT, discussion on choosing a surrogate species is confined to the use of insect pest species to substitute for target species when the target species is difficult or impossible to obtain or use in research on developing a phytosanitary treatment.

Target species: The species that is of quarantine concern to an importing country.

Surrogate species: The species that is tested instead of the target species.

A suitable surrogate species may be as tolerant or preferably more tolerant than the target species and must respond as closely as possible to the treatment as the target species.. When a surrogate species is

[44]Pseudoreplication is used to test for treatment effects with data from experiments where either treatments are not replicated (though samples may be) or replicates are not statistically independent. The error described by this term arises when treatments are assigned to units that are subsampled and the treatment F-ratio in an analysis of variance (ANOVA) table is formed with respect to the residual mean square rather than with respect to the among unit mean square. The F-ratio relative to the within unit mean square is vulnerable to the confounding of treatment and unit effects, especially when unit number is small (*e.g.* four tank units, two tanks treated, two not treated, several subsamples per tank). The error is avoided by forming the F-ratio relative to the among unit mean square in the ANOVA table (tank MS in the example above). Pseudoreplication, as originally defined, is a special case of inadequate specification of random factors where both random and fixed factors are present: http://en.wikipedia.org/wiki/Pseudoreplication

used in developing a phytosanitary treatment the TPPT needs to see justification that the surrogate species is a suitable substitute for the target species.

The following attributes may be used in providing such a justification. Similarity between the target species and the surrogate species in:

- Order, Family, Genus, Species (different strain, sub-species, variant, etc) ["taxonomic distance"]
- Host (i.e. target product) and host range
- Life history, phenology, size
- Feeding regime
- Reaction to treatment
- Tolerance to treatment (preferably less tolerant at same temperature, duration of exposure, dose concentration, etc) ["toxicologically representative"]
- Habitat type (e.g. tropical, temperate)
- Level of damage to target product and the part/s of target product damaged
- Published supporting scientific literature and/or existing international / bilateral approvals.

Selected reading includes the following:

ASTM. 2002. Standard Terminology Relating to Biological Effects and Environmental Fate. Standard E 943-00 in: *Annual Book of Standards. Vol. 11.05 Biological Effects and Environmental Fate; Biotechnology; Pesticides.* ASTM International, West Conshohocken, PA

Hoover, K. Haack, R. Magnusson, C. 2010. Criteria for selecting substitute organisms for target pests in treatment testing. Eighth Meeting of the International Forest Quarantine Research Group, Lisbon, Portugal, 2010: Document 34.

Ormsby, M. 2009. Developing phytosanitary treatments for international trade. *In*: IUFRO International Forest Biosecurity Conference Incorporating the 6th International Forest Vegetation Management Conference. 16-20 March 2009, Rotorua, New Zealand *Eds*: Margaret Richardson, Carolyn Hodgson, Adrienne Forbes. New Zealand Forest Research Institute Limited.

Raimondo, S., Vivian, D.N., and Barron, M.G. 2010. Web-based Interspecies Correlation Estimation (Web-ICE) for Acute Toxicity: User Manual. Version 1.1. EPA/600/R-10/004. Gulf Breeze, FL.

Wenger, S. J. 2008. Use of Surrogates to Predict the Stressor Response of Imperiled Species. *Conservation Biology*, 22(6):1564–1571.

6. Determination of a suitable treatment endpoint

As stated in ISPM 18 (2003) but which is equally applicable to all treatments:

The objective of using irradiation as a phytosanitary measure is to prevent the introduction or spread of regulated pests. This may be realized by achieving certain responses in the targeted pest(s) such as:

- mortality
- preventing successful development (e.g. non-emergence of adults)
- inability to reproduce (e.g. sterility), or
- inactivation

Typically, the most advanced developmental stage of the insect occurring in the commodity is the most tolerant when the measure of efficacy is preventing further development or reproduction (Hallman *et al.* 2010). In the case of tephritid fruit flies, preventing adult emergence could be considered the desired response required for regulatory purposes because it prevents the emergence of adult flies that could be trapped and trigger regulatory actions (ISPM 28 Annex 7, 2009). However,

when the insect pupates in the host, preventing adult emergence may require an excessive treatment dose as is the case with irradiation, so prevention of development of the F_1 generation may be a more achievable measure of efficacy (Hallman *et al.* 2010).

From the very beginnings of the idea of using irradiation as a phytosanitary treatment, Koidsumi (1930) proposed that the measure of efficacy should be prevention of adult emergence rather than mortality to previous stages. This would satisfy the phytosanitary requirement of preventing the establishment of invasive species without necessarily acute mortality of the stages treated. The advantage would be that treatment would be more economical and less damaging to product quality. Unfortunately this means that live, though sterile, insects might be found in the product by inspectors and mistaken for fertile quarantine pests.

It therefore makes the independent verification of treatment efficacy used by other phytosanitary treatments, acute mortality of the treated lifestage, unusable for treatments that prevent adult emergence or result in adult sterility. An alternative form of verification could test the detected lifestage for evidence of treatment application e.g. treatment residues or chemical changes in the pest. In the case of irradiation, there is currently no easy procedure available to identify whether or not an adult insect is irradiated or not, sterile or fertile, so if such adults were trapped subsequently costly regulatory actions would be instigated.

Considerations:

The following should be taken into consideration when deciding on a suitable treatment end-point:

Treatment must cause mortality of the exposed life-stage(s).

This treatment outcome should ensure no live pests are found in the treated product on inspection at the destination country. However consideration should be taken of the method used by the importing country to verify pest mortality. While successful treatments may result in pest mortality, it may take several days or more for the target pests to cease metabolic activity (see Philips *et al.* 2014). Pests that are moribund but still alive after treatment may indicate a failed treatment when using chemical mortality tests to verify treatment success.

Treatment must prevent successful development.

If pupation occurs in the treated commodity then treatment must prevent the eclosion of adults. If adults typically occur in the product then treatment must cause 100% mortality of the adults. In the case of irradiation, to satisfy these requirements the necessary irradiation dose would be too high for the product being treated to tolerate.

Treatment must prevent adult emergence.

It is possible that live immature life stages of the target insect may be present in the treated product. These insects would be sterile and there is sufficient published evidence for this assertion.

This requirement is the 'traditional' criterion for treatment efficacy for irradiation treatments and also, at least in some jurisdictions, other quarantine treatments such as cold disinfestation and fumigation.

There are currently no simple methods available which can be used to identify whether or not treatment has been carried out correctly by testing the recovered insect. While there are dosimeters and coloured labels (e.g. "Rad Tags") that change colour when correctly dosed, pre-coloured tags may be misused.

Suitably robust certification of the application of the quarantine treatment could cover concerns that immature insects found inside the fruit will be sterile.

Treatment must cause sterility of target insect pests.

Again there is the likelihood that live immature pest life stages will be found in treated product.

However an additional complication is that live, but sterile adults may escape into the importing locality and be trapped thereby triggering exotic pest incursion activities and restrictions.

Until simple and reliable techniques are readily available with which to identify insects found in quarantine traps as being treated and sterile, it will be difficult for importing authorities to accept sterility as a suitable end-point for a phytosanitary treatment.

If a researcher can prove to the satisfaction of importing authorities that insects surviving treatment will be sterile, and will not be able to survive long enough or migrate far enough to be a problem in trapping grids, then the treatment efficacy end-point of adult sterility could be used with phytosanitary certification.

While some research has shown that these insects may not be able to mate, or if they do mate their eggs are 100% infertile. These facts, while acting to ensure quarantine security, should the insects escape into the environment, will not be acceptable to importing authorities if these insects can fly or otherwise move to surveillance traps.

6.1 Selected references

Hallman *et al.* (2010)

Koidsumi (1930)

TPPT Position paper on adult emergence after irradiation (2013)[45]

7. General considerations for temperature treatments

The panel considered issues associated with treatments based on temperature, taking into account the work of Hallman and Mangan (1997). In 2009 the panel recommended a number of principles that should be applied when evaluating temperature treatments for adoption as international standards (outlined below).

7.1 Mortality assessments

When assessing mortality, any larvae that are found alive should be considered survivors whether or not they subsequently fail to pupate or survive to adults. This takes account of the fact that in practice on phytosanitary inspection any live insect found will be considered a survivor.

7.2 Genotype of insect

It is possible that laboratory-bred colonies of insects may become more susceptible to temperature-based treatments over time. The panel is not aware of any research having been undertaken to demonstrate whether this is an issue in reality. The panel considers that as long as the colonies used in the research have been established or reinvigorated before the research, issues such as these should not be considered significant subject to research showing otherwise.

7.3 Pre-treatment acclimation

Insects may be less susceptible to temperature treatments depending on the conditions they are exposed to immediately prior to treatment. The panel considers that where this may be an issue, pre-treatment requirements should be included in any recommended treatment schedule.

7.4 Commodity variability

To provide confidence that temperature treatments are applicable internationally, host material used in research should be sampled from as wide a geographic area as possible and unexpected results should be considered with care.

[45]TPPT September 2013 Virtual meeting report

7.5 Scale of treatment application

The panel should consider any possible reduction in effectiveness of temperature treatments that may occur when treatments are scaled up and applied in commercial conditions.

7.6 Rate of temperature change

Where the rate of temperature change of the commodity may be considered significant to the effectiveness of a temperature treatment, this should be specified in the treatment schedule.

7.7 Determining the most tolerant life stage

The most tolerant life stage should be determined using hosts and pests under normal conditions of infestation and treatment parameters, using a common measure of efficacy. If conditions are different, it should be demonstrated that these differences are equivalent to normal conditions. For instance, if artificial inoculation is used, this should be similar to the host and pest found in nature, e.g. depth in commodity and level of infestation.

When developing mortality curves, life stages should be exposed to as close to the target temperature as possible for different periods.

8. General considerations for wood packaging material heat treatments

The panel considered the following issues when evaluating wood packaging material heat treatments for adoption as international standards (outlined below).

8.1 Mortality assessments

When assessing mortality, the target life stage should be that most likely to be present in the wood at the time of treatment. Any target life stage found alive should be considered a survivor whether or not it subsequently fails to survive to adulthood or produce offspring. This takes account of the fact that in practice on phytosanitary inspection any live life stage found will be considered a survivor.

8.2 Environmental factors

Consideration should be taken of potential environmental effect on the efficacy of the treatment under conditions expected to be encountered at the time of treatment (such as wood moisture content or density). Unexpected results should be considered with care.

8.3 Pre-treatment acclimation

Target pests may be less susceptible to temperature treatments depending on the conditions they are exposed to immediately prior to treatment. The panel considers that where this may be an issue, pre-treatment requirements should be included in any recommended treatment schedule.

8.4 Scale of treatment application

The panel should consider any possible reduction in effectiveness of temperature treatments that may occur when treatments are scaled up and applied in commercial conditions.

8.5 Rate of temperature change

Where the rate of temperature change of the commodity may be considered significant to the effectiveness of a temperature treatment, this should be specified in the treatment schedule.

8.6 Heating process

Consideration should be taken of the heating process (e.g. heating from inside out or outside in) and the conditions that need to be met before the treatment can commence.

9. General considerations for wood fumigation treatments

The panel considered the following issues when evaluating wood fumigation treatments for adoption as international standards (outlined below).

9.1 Mortality assessments

When assessing mortality, the target life stage should be that most likely to be present in the wood at the time of treatment. Any target life stage found alive should be considered a survivor whether or not it subsequently fails to survive to adulthood or produce offspring. This takes account of the fact that in practice on phytosanitary inspection any live life stage found will be considered a survivor.

9.2 Environmental factors

Consideration should be taken of potential environmental effects on the efficacy of the treatment under conditions expected to be encountered at the time of treatment. Wood factors such as moisture content, density, porosity and presence of bark should be considered along with temperature. Unexpected results should be considered with care.

9.3 Scale of treatment application

The panel should consider any possible reduction in effectiveness of fumigation treatments that may occur when treatments are scaled up and applied in commercial conditions.

10. General considerations for cold treatments

The panel considered the issues associated with treatments based on temperature, taking into account the work of Hallman and Mangan (1997). The panel recommended a number of principles that they should apply when evaluating temperature treatments for adoption as international standards (outlined below).

10.1 Mortality assessments

When assessing mortality, any larvae that are found alive should be considered survivors whether or not they subsequently fail to pupate or survive to adults. This takes account of the fact that in practice on phytosanitary inspection any live insect found will be considered a survivor.

10.2 Genotype of insect

It is possible that laboratory-bred colonies may become more susceptible to temperature-based treatments over time. The panel is not aware of any research having been undertaken to demonstrate whether this is an issue in reality. The panel considers that as long as the colonies used in the research have been established or reinvigorated before the research, issues such as these should not be considered significant subject to research showing otherwise.

10.3 Pre-treatment acclimation

Insects may be less susceptible to temperature treatments depending on the conditions they are exposed to immediately prior to treatment. The panel considers that where this may be an issue pre-treatment requirements should be included in any recommended treatment schedule.

10.4 Commodity variability

To provide confidence that temperature treatments are applicable internationally, host material used in research should be sampled from as wide a geographic area as possible and unexpected results should be considered with care.

10.5 Scale of treatment application

The panel should consider any possible reduction in effectiveness of temperature treatments that may occur when they are scaled up and applied in commercial conditions.

10.6 Rate of temperature change

Where the rate of temperature change of the commodity may be considered significant to the effectiveness of a temperature treatment, this should be specified in the treatment schedule.

10.7 Issues associated with drafting of the treatment descriptions for cold treatments

When drafting the treatment descriptions from the different submissions, the TPPT noted that one submission related to two fruit flies on a number of different hosts. Other submissions were for the same fruit fly species and host commodity. The TPPT therefore made the following decisions regarding the treatment descriptions:

Each treatment should be for an individual fruit fly species.

For fruit fly hosts, the TPPT was aware that several countries had found different *Citrus* species responded to cold treatment differently. Treatments should therefore be produced for separate *Citrus* species.

Regarding cultivars of *Citrus* species, the TPPT was aware that certain research may have indicated that different cultivars of *Citrus sinensis* (orange) responded differently to cold treatments and decided to quote the treatment efficacies for the different cultivars of *C. sinensis* separately in the treatment description. (TPPT will do further review on the issue of differences in treatment outcomes between *C. sinensis* cultivars.) For the other *Citrus* species, the TPPT was not aware of different responses by cultivars and therefore there was no differentiation according to cultivar for these species.

Treatments involving the same fruit fly species and host (for example *Ceratitis capitata* on *Citrus sinensis*) were included as different schedules in the same treatment description.

Regarding temperatures sensitivities (e.g. 2^{o}C +/- 0.5^{o}C), these were not added to the treatment schedules. In some submissions the temperature limits were quoted, but the TPPT noted that experimental probes were often more sensitive than commercial probes. The TPPT therefore decided to include a sentence in the treatment descriptions indicating that 'the stated temperatures should not be exceeded'. Commercial operators would need to take into account the normal working range of their equipment in order to meet this requirement.

11. General considerations for irradiation treatments

The panel considered the issues associated with treatments based on irradiation, taking into account the work of Hallman and Mangan (1997). The panel recommended a number of principles that they should apply when evaluating irradiation treatments for adoption as international standards (outlined below).

11.1 Extension of treatments to all fruits and vegetables

The efficacy of irradiation treatments can be extrapolated to all fruits and vegetables. Confidence was based on experience in the application of irradiation treatments and evidence from studies on *Anastrepha ludens, A. suspensa* and *Bactrocera tryoni* (Bustos *et al*., 2004; Gould & von Windeguth, 1991; Hallman & Martinez, 2001; Jessup *et al*., 1992; von Windeguth 1986; von Windeguth & Ismail, 1987).

The panel recognised, however, that treatment efficacy has not been tested for all potential fruit and vegetable hosts of the submitted target pests. If evidence becomes available to show that the extrapolation of treatments to cover all hosts of the target pests is incorrect, then the treatments should be reviewed.

11.2 Extension of treatments to all populations within a species

The panel considered whether the scope of submitted irradiation treatments could be extended to cover all strains and biotypes of the target pests concerned.

The panel was confident that the extrapolation of efficacy to all strains and biotypes of the target pests could be made for the irradiation treatments that had been submitted. This confidence was based on the absence of published evidence for significant differences between subspecies and biotypes in their radiation tolerance, including a study comparing strains of one target pest by Hallman (2003). The panel also recognised that recommended minimum doses are higher than otherwise required and should account for any minor differences in intra-species tolerances that may exist.

The panel recognised, however, that treatment efficacy has not been tested for all potential strains and biotypes of the submitted target pests. If evidence becomes available to show extrapolation of treatments to cover all strains and biotypes is incorrect, then the treatments should be reviewed.

11.3 Extension of species to the whole genus

The panel considered whether the scope of submitted irradiation treatments could be extended to cover all species in a genus of the target pests concerned.

The panel noted that Bakri *et al*. (2005) had indicated that, with few exceptions, there was no need to develop radiation biology data for all species within the same genus. The panel considered that a case for extrapolating irradiation doses to all species within a genus would need to be explored more fully in any submission.

11.4 Extending beyond genus to family

The panel considered whether the scope of submitted irradiation treatments could be extended to cover all genera in a family of the target pests concerned.

The TPPT noted that within Tephritidae a wide range of genera has been tested and this had supported extending irradiation treatments to the Family level in this case (report of 2006 meeting).

It was noted that for other insect families it would be impossible to get sufficient data to confirm that all genera within a family conform to the same treatment dose. This would be an enormous undertaking, which is unlikely to happen. The panel considered that a case for extrapolating irradiation doses to all genera within a family would need to be explored more fully in any submission.

11.5 Determination of the most tolerant life stage of the target pest(s)

The panel noted that the insect life stage that is most tolerant to irradiation is the most advanced stage when identical objectives are measured (e.g. prevention of adult emergence). The treatments only need to be effective for those life stages likely to be encountered in the traded commodity.

11.6 Effect of environmental conditions

The panel considered whether the scope of submitted irradiation treatments could be extended to cover treatments undertaken in all environmental conditions likely to be encountered under commercial conditions.

The panel was confident that the extrapolation of efficacy to all likely temperatures could be made for the irradiation treatments that had been submitted. Confidence was based on experience in the operation of irradiation treatments and evidence from studies on *Rhagoletis pomonella* (Hallman, 2004).

The panel noted that lowered oxygen conditions (hypoxia) may affect the efficacy of irradiation treatments. Unless the treatment has been determined to be effective under hypoxic conditions, the panel considers that to achieve the stated treatment efficacy the irradiation treatment should not be applied to fruit and vegetables stored in modified atmospheres.

11.7 Non-target effects of irradiation

The panel considered that the only potentially significant non-target effects of the irradiation treatments that were reviewed at the meeting were those affecting commodity quality. The research

presented indicated that there would be minimal adverse effects at the prescribed dosages to the commodities tested. In some circumstances the research indicated that the irradiation treatments may enhance product quality through extending shelf life. However, the panel has recommended extending the treatments to all fruits and vegetables, including those that have not been tested or have been shown to be negatively impacted by relatively low irradiation doses. The panel therefore recommends that, prior to approving an irradiation treatment; NPPOs may wish to take account of any potential non-target effects of the treatment.

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Appendix 6: TPPT Work Programme 2014-2015

2014 DUE DATE	RESPONSIBLE	ACTION
4 July	**Niyazi/all members**	2015 Meeting Date Confirmation
4 July	**Niyazi**	Editing of the TPPT response to FOs
4 July	**Treatment leads**	Finalisation of Treatment Evaluations for the 2014 TPPT meeting report
11 July	**All members**	Finalisation of the TPPT response to FOs
11 July	**Niyazi**	Issuance of final notice letter to submitter of topic 2009-108 (Vapour heat treatment for *Mangifera indica* var. Manila Super)
4 July	**Shamilov**	Forum for Meeting Report opens
17 July	**All members**	Finalisation and approval of the 2014 Meeting Report
23 July	**Shamilov**	Posting of 2014 Meeting Report
August	**Niyazi/ All members**	Forum discussion on TPPT position paper on "Characterisation of heated air treatments"
1 Sept.	**Jessup**	Revision of "TPPT recommendations for future research on HTFA treatments"
1 Sept.	**Ormsby**	Revision of "Technical Support Document for Glossary Definition of Effective Dose"
TBD	**Niyazi/ All members**	Forum discussion on "TPPT recommendations for future research on HTFA treatments"
Early September	**Niyazi/ All members**	Forum discussion on position paper on "instructions to assist NPPOs and RPPOs in proper and complete submissions"
	Ormsby	Revision of position paper on "instructions to assist NPPOs and RPPOs in proper and complete submissions" (to be attached to call for treatments later)
	Rossel	*Liaison with SC members for any additional comments and revision of "Draft specifications for ISPM: Requirements for the use of phytosanitary treatments as phytosanitary measures (2014-008)"*
Dec 2014	**Hallman**	Development of position paper on the use of extrapolation to estimate treatment efficacies
23 Sep 2014 (tent.)		TPPT virtual meeting (Adobe Connect)
16 Dec 2014 (tent.)		TPPT virtual meeting (Adobe Connect)
2015		**ACTION**
24 March (tent.)		TPPT virtual meeting (Adobe Connect)
End-June		TPPT virtual meeting (Adobe Connect)
End-Sept.		TPPT virtual meeting (Adobe Connect)
26-30 Oct.		2015 TPPT Meeting (Japan)