EXPLANATORY DOCUMENT
ON
INTERNATIONAL STANDARD FOR PHYTOSANITARY MEASURES
No. 18
(*GUIDELINES FOR THE USE OF IRRADIATION AS A PHYTOSANITARY TREATMENT*)

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January 2006

Note: Explanatory documents for International Standards for Phytosanitary Measures (ISPMs) are produced as a result of a decision of the Interim Commission on Phytosanitary Measures in 2004 (reported on paragraph 111 of the report of ICPM-6). They are written to provide supporting information to the standard they refer to and cannot be taken as an official legal interpretation of the IPPC or its related documents, and are produced for public information purposes only. Each document is written by an expert, reviewed by at least two peers (usually from the Expert Working Group concerned), then reviewed by the Standards Committee and the IPPC Secretariat. However, the material presented in explanatory documents remains the opinion of the writer and cannot be interpreted as a decision of the ICPM. It is hoped that most standards will have one or more explanatory documents associated with them.

PURPOSE OF ISPM No. 18

The purpose of this standard is to harmonize the use of irradiation as a phytosanitary treatment internationally. Irradiation is new in application, as the first commercial treatments to occur on a continuing basis began in 1995. Still, by 2001 it was only being used by two US states to ship quarantined commodities to other US states. As of this writing the only international use of irradiation as a phytosanitary treatment on a continuing basis is for mangoes from Australia to New Zealand, and this was initiated in December of 2004.

Irradiation has some significant differences compared with other commercially used phytosanitary treatments (fumigation, heat, and cold), and it was decided that a standard would be important in achieving recognition of these differences. These differences stem from the fact that irradiation in the doses used for phytosanitary purposes (70-400 Gy) does not cause rapid mortality. Organisms that regulatory inspectors find will likely be alive, although they will eventually die without successfully reproducing.

GENERAL FORM OF THE STANDARD

Keeping in mind that this standard might be the first of several phytosanitary treatment standards, it was organized in a fashion that could provide a template for other standards. Major sections are treatment objective, application of the treatment, measurement of the required treatment parameters (foremost among them being dose), the treatment facility, phytosanitary security, documentation and inspection. Two annexes provide specific approved treatments (currently none are listed) and a checklist for facility approval. Two appendices give a table with estimated radiation dose ranges that might be efficacious against several pest groups and a general research protocol.

CONTENTS OF THE STANDARD

2. Treatment Objective

The first response listed, mortality, is required by all other phytosanitary treatments but is not considered practical for irradiation. The doses required to achieve 100% mortality of arthropods within 24 hours after treatment are too high (a few to several kilogray) for fresh commodities to tolerate. Furthermore, mortality is not necessary to prevent an infestation. The next two responses listed, preventing development or reproduction, will suffice to prevent an infestation, and these responses irradiation accomplishes for most arthropods with 400 Gy or less. The fourth response, inactivation, generally refers to making microorganisms incapable of reproducing.

2.1 Efficacy

This section defines more precisely the treatment objective. For example, it may not be sufficient to make the objective “inability to reproduce” without defining how this is measured. For example, an irradiated insect could lay eggs but these do not hatch. Therefore, an inspector finding eggs would not be alarmed as long as no hatched eggs were found.

3. Treatment

A list of variables is given to consider their compatibility with treatment effectiveness. There is a little indication in the literature that some of these variables might affect irradiation efficacy. However, the one that has been confidently shown to reduce treatment efficacy for some pests, such as weevils and lepidopterous larvae, is hypoxia. This is important because low-oxygen storage is increasingly being used for some fresh commodities to prolong shelf life. Irradiation as a phytosanitary treatment of products stored under low oxygen conditions should not be done until efficacy under low oxygen conditions is established.

The last paragraph of this section mentions the problem with live pests. Presently irradiated pests cannot be practically distinguished from non-irradiated ones soon after irradiation, although as they continue to develop irradiated pests will be seen not to develop or reproduce successfully. Irradiated pests will usually die prematurely, although in some cases irradiated pests have lived longer than non-irradiated ones.

3.1 Application

This section introduces Annex 1 (specific approved treatments), although no treatments are yet listed. Some could be included, but it has not been determined how this will be done. Appendix 1 (possible dose ranges to control certain pest groups) is also introduced. These possible ranges taken from the literature, but they need to be confirmed with large numbers of organisms tested before they could be offered as phytosanitary treatments. It is stated that the list is not static. One example of this is that recent research has reduced the upper dose range for fruit flies from 250 to 150 Gy (Hallman and Loaharanu 2002) and for stored product moths from 1,000 to 600 Gy (IAEA 2004). The website referenced at the end of Appendix 1 is no longer functioning and refers the user to the Joint Food and Agriculture Organization/International Atomic Energy Agency Food and Environmental Protection Section website.

4. Dosimetry

Accurate dosimetry is fundamental to the correct application of irradiation. If the dose is not measured correctly, efficacy cannot be assured. Because irradiation at the doses used for phytosanitary treatments does not result in rapid death, inspectors will have no clue if the dose was greatly overestimated resulting in possible treatment failure.

6. Phytosanitary System Integrity

Because of the same problem of lack of dead insects as an easy check on the efficacy of the entire system, the system should function to a higher quality standard than any other phytosanitary treatment system. If irradiation fails and viable pests get through, it may possibly never be known that it was the system that failed. In nearly every case where a phytosanitary treatment system was found to fail, it was discovered by the presence of live insects.

7. Documentation

Documentation, including dosimetry records, takes on a greater importance for maintaining compliance with the requirements of the phytosanitary system for irradiation compared with other phytosanitary treatment systems. Records may be the chief way to determine after the fact if the irradiation system has failed and possibly led to a pest outbreak, and to examine measures to prevent reoccurrence.

8. Inspection and Phytosanitary Certification by the NPPO

Again, because of the acceptance of live pests when using irradiation, documentation verification should be more closely monitored than may be needed for other treatments where dead pests after treatment are the norm.

Examination for non-target pests is more critical than for other treatments because with other treatments if the non-target pests are dead, generally the treated commodity is accepted. With irradiation, any non-target quarantine pests present may very well be alive and the commodity cannot be accepted unless data confirming efficacy against these non-target pests are available.

APPENDIX 1

Appendices present information and are not legally binding, as are indices. There was considerable discussion whether to include Appendix 1 in the standard. The contrary argument centered on whether readers would assume that the estimated doses were proven and recommended for use. Some argued that it would be better to not include possible doses for specific groups until they were proven efficacious and ready to be used. But the table was included with abundant cautions against accepting the doses as prescriptive. However, that has still not prevented people from thinking that it is prescriptive.

APPENDIX 2

This appendix offers suggestions for conducting research on irradiation phytosanitary treatments. Because of the lack of an easy check on irradiation efficacy (no dead pests shortly after treatment), the research should be done to a higher level of quality than research for other treatment where dead pests are the measure of efficacy. Also, because the measure of efficacy for irradiation is not death and does not occur soon after treatment, research on irradiation phytosanitary treatments is more difficult than research on other treatments.

The recommendation of a minimum of 5 dose levels for each developmental stage (when testing for most radio-tolerant stage) is not hard-fast. Sometimes only one dose level may suffice.

It is stated that mortality in the control should not exceed 10%, but that may be hard to achieve with some pests.

MAJOR CONCERNS DURING STANDARD DEVELOPMENT

As was mentioned before, Appendix 1 (estimated effective doses for some pests groups) generated some concern.

Also, whether or not to recommend radiation-sensitive indicators (not dosimeters) as tools to ensure that the treatment was done correctly was discussed and rejected. The issue of indicators resurfaces in other discussions of irradiation phytosanitary treatments, but is usually rejected because of the poor accuracy achieved given the added cost.

The term “required response” was introduced in this document and has come to replace “end point” used in previous documents. Required response takes into consideration how efficacy is measured and to what level of security, whereas endpoint has usually meant only how efficacy is measured, and often without much precision. For example “prevention of reproduction” is insufficient as a required response. How that prevention is observed (e.g., no eggs laid, no eggs hatching, no development beyond first instar) is more precise.

There was some argument over the difference between inactivation and devitalization, and that was clarified in the definitions.

ANNOTATED ADDITIONAL REFERENCES

Two web-sites and two printed references are cited in Appendix 1, page 20. As mentioned before, the last reference is no longer available but refers one to an IAEA web site. Three other references are suggested as additional background to the standard.

Along with the first reference (database) is a recent article summarizing fifty years of radiation entomology. Much of that history involves research into irradiation as a phytosanitary treatment.

> Bakri, A., Heather, N, Hendrichs, J. and Ferris, I. 2005. Fifty years of radiation biology in entomology: lessons learned from IDIDAS. Journal of Economic Entomology 98: 1-12.

The following book chapter provides an overview of phytosanitary treatments, comparing irradiation with others. It will help the reader understand the importance of phytosanitary treatments.

> Hallman, G.J. 2002. Quarantine treatments: achieving market access for agricultural commodities in the presence of invasive pests, pp. 271-291 in Hallman, G.J. and Schwalbe, C.P., Invasive Arthropods in Agriculture: Problems and Solutions. Science Publishers, Enfield, NH, USA.

The following article argues for a generic, default dose of 150 Gy for all tephritid fruit flies, which is now being studied for approval by the US Department of Agriculture, Animal and Plant Health Inspection Service. This argument could be considered to include fruit flies in Annex 1 of the standard.

> Hallman, G.J. and Loaharanu, P. 2002. Generic ionizing radiation quarantine treatments against fruit flies (Diptera: Tephritidae) proposed. Journal of Economic Entomology 95: 893-901.

The following document reports on a recent final research coordination meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and held in 2002. It is the source for information lowering doses for stored product moths from 1,000 to 600 Gy.

> IAEA. 2004. Irradiation as a phytosanitary treatment of food and agricultural commodities. IAEA-TECDOC-1427. IAEA, Vienna.