Movement of Commercially Packed Citrus Fruit from Citrus Canker Disease Quarantine Area

Response to peer review

United States
Department
of Agriculture

Animal and
Plant Health
Inspection Service

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1 Introduction

Following Office of Management and Budget (OMB) guidance (OMB 2004), the risk management analysis published with the proposed rule for amending the citrus canker regulations to modify the conditions under which fruit may be moved interstate from a quarantined area (FR 2007) was submitted for peer review. The analysis was reviewed by three experts in the fields of citrus diseases, plant pathogenic bacteria and quantitative risk assessment. Each reviewer addressed specific issues raised in the peer review charge. In particular, the reviewers were asked:

1. Does the analysis clearly characterize the potential, or lack thereof, for commercially packed citrus fruit to serve as a pathway for the introduction and/or spread of *Xanthomonas axonopodis* pv. *citri*?
2. Are the data or other evidence complete? If not, please indicate significant references that should be included.
3. Does the analysis accurately characterize the cited literature?
4. With regard to the methodology, is the approach and process appropriate for the analysis?
5. Are all important assumptions identified and uncertainties clearly stated?
6. Is any part of the document difficult to read or understand?
7. Were the quantitative methodologies used in this assessment applied appropriately to achieve the objectives of the inspection efficacy assessments?
8. Do the data and the evidence support the range of risk management options presented?
9. Is the logic behind the choice (or rejection) of risk management options clearly stated and supported by data and evidence presented?

The charge to the reviewers, the original and revised risk assessments, and the peer review report are available at http://www.aphis.usda.gov/peer_review/peer_review_agenda.shtml.

The reviewers were generally supportive of the methods, evidence, and conclusions presented by the Animal and Plant Health Inspection Service (APHIS) in the risk management analysis. They also asked a variety of questions and suggested minor refinements. We made changes to the risk management analysis in response to editorial suggestions, without noting them individually here. In this document, we respond to the content-related comments and questions raised by the reviewers. We indicate in each case whether we have amended the risk management analysis in response to the comment.

2 Comments and Responses

2.1 Does the analysis clearly characterize the potential, or lack thereof, for commercially packed citrus fruit to serve as a pathway for the introduction and/or spread of Xanthomonas axonopodis pv. citri?

Comment: *However, in my opinion, the potential importance of epiphytic populations that might remain on the surface of fruit outside of lesions is given an inordinate amount of importance. I realize that this is due to the fact that opponents of movement of commercial fruit have used the survival of a few bacteria on the fruit surface to prove that all risk cannot be eliminated.* (Reviewer 2)
Response: A number of comments received after the publication of an earlier pest risk assessment entitled "*Evaluation of asymptomatic citrus fruit (Citrus spp.) as a pathway for the introduction of citrus canker disease"* (USDA 2006) focused on the potential role of epiphytic bacteria in the spread of citrus canker disease. Consequently, we felt it was important to cover all the available evidence on this topic.

2.2 Are the data or other evidence complete? If not, please indicate significant references that should be included.

Comment: *Thus, the conclusion based on review of the literature, in both the Executive Summary, may need to be modified, if it is true that significant levels of leaf miner could negate the requirement for Florida-like environmental conditions. Another consideration that is not mentioned is the citrus peel miner (Marmara gulosa), which is a problem sporadically in central California.* (Reviewer 1)
Response: We are aware of studies that indicate that leafminer damage increases the incidence and severity of citrus canker disease in areas where the disease already occurs, but our review of the literature did not find any reports that document spread of citrus canker disease to new areas because of leafminer damage. We also did not find any reports of the interaction of citrus canker disease and the citrus peel miner.

Comment: *The only area that has not been addressed that seems to me to be relevant is the risk involved in movement of citrus canker by means other than commercially packed fruit. Canker can be moved on living plant material, on fruit, budwood, and vegetative materials brought in by growers, nurserymen, hobbyists and tourists illegally and those means of entry are the most likely method for introduction of canker and most other exotic diseases.* (Reviewer 2)
Response: We agree that the relative risk of spreading citrus canker disease is greater for citrus plants. We illustrated this point in the section of the risk management analysis

entitled “The Origins of Citrus Canker Disease Outbreaks.” However, the scope of this regulatory action is limited to the interstate movement of citrus fruit.

Comment: *Although I agree that the required sequence of events is unlikely, I’m not yet convinced that sufficient thought has been given to potential pathways for establishment of Xac in previously canker-free areas due (perhaps indirectly) to transport of commercially-packed fruit. For example, rinds from commercially-packed fruit may be incorporated into compost, which may then come into contact with citrus trees, providing another potential establishment pathway. (This example also shows how establishment pathways that are operationally defined as separate may actually intersect. I do not consider this omission a serious weakness in the document, because the qualitative risk assessment indicates that this pathway may be even less likely than establishment via direct contact with commercially-packed fruit. I only mention this possibility to show that there are many imaginable ways in which citrus canker might become established.)* (Reviewer 3)
Response: Composting becomes part of the establishment equation as part of the consideration of the citrus canker bacteria coming in contact with host material. The purpose of the risk management analysis was to develop and evaluate risk management options for one specific pathway—commercially packed citrus fruit. Much thought went into qualitatively describing the potential pathways for establishment, and we determined that it is unlikely that commercially packed citrus fruit could serve as such a pathway. Though we would like to quantify the likelihood of establishment (direct and indirect) via commercially packed citrus fruit, we do not have enough data or evidence to credibly and accurately model (considering the impact and the likelihood of Xac bacterial transfer via various pathways) and quantify any of the potential establishment pathways. As such, we ended the quantification at entry of infected fruit to citrus growing areas in each state, and for each variety of citrus. Other pathways are outside the scope of the model. However, we did qualitatively evaluate several pathways similar to those cited by the reviewer in the RMA section headed "Environmental and Epidemiological Conditions Required for Xac Establishment."

Comment: *Are organic citrus groves likely to be more at risk as potential establishment sites than conventionally-tended citrus groves?* (Reviewer 3)
Response: We lack data on which production practices might not be employed in organic citrus groves that might increase the risk of establishment in such groves. Having said that, this scenario is somewhat of a *non sequitur* given the choice of risk management Option 4 that will prohibit movement to citrus-producing States.

Comment: *I would like to have seen more on the implications of climatic differences in the potential susceptibility of the other citrus-growing states to novel Xac infestations, and the implications of these differences for the risk management options considered. (For example, could shipments to the other five citrus-producing states have been considered separately as non-mutually-exclusive risk management options?*) (Reviewer 3)

Response: If natural climate were the only risk factor that distinguished the States, then we could qualitatively conclude that potential susceptibility to citrus canker is less in California than in Louisiana or Texas. However, variations in the amount of rainfall within each State, and the use of irrigation in areas with less rainfall, serve to blur that conclusion. These factors, along with the fact that we cannot limit distribution to any area less than an entire State, would make it difficult to model and evaluate risk management options separately for each citrus-producing State.

Comment: *It also seems to me that that the extension services of the other five citrus-growing states need to be producing and promoting a vigorous program of public education informing people of the danger, however small it may be, of citrus canker establishment in their area, and of things they can do to reduce the danger (like not discarding orange rinds from their lunch in a citrus grove).* (Reviewer 3)
Response: While we agree with the sentiment of this statement, and we believe such education programs are already in place, we believe this is outside the scope of the subject analysis and does not represent data nor evidence that are missing from the analysis.

2.3 Does the analysis accurately characterize the cited literature?

Comment: *I suggest adding the article on leaf miner damage mentioned above that appeared in Crop Protection just recently [Christiano 2007]*. (Reviewer 1)
Response: A reference to this journal article has been added to the risk management analysis.

Comment: *One point that should be included in the document is that the windbreak study by Gottwald and Timmer (1995) was carried out under nursery rather than grove conditions.*
Response: The risk management analysis has been modified to reflect this distinction.

2.4 With regards to the methodology, are the approach and process appropriate for the analysis?

The comments we received indicated that our approach and process were appropriate for the analysis.

2.5 Are all important assumptions identified and uncertainties clearly stated?

The comments we received indicated that our important assumptions were identified and our uncertainties were clearly stated.

2.6 Is any part of the document difficult to read or understand?

Comment: *To improve it, I would suggest organizing section 5 to more closely reflect the wording that is used on page 7 for the six main reasons why previous analyses have concluded that there is a low likelihood of introducing citrus canker through movement of fruit. The same wording for each numbered reason should be copied and used as the headings for the subsections in section 5, just as one would do with the objectives of a grant proposal and their subsequent use as headings in the experimental section of a proposal. The worse way to write a grant proposal is to present a list of objectives, and then in the experimental section, use headings that reword or change the objectives.* (Reviewer 1)
Response: The headings in section 5 of the risk management analysis have been revised to reflect the comment.

Comment: *The discussion of the quantitative model (Appendix 1) probably should be brought into an earlier section of the document, rather than waiting until the discussion of risk management option 2 on page 31. The findings of the model are relevant to the discussion of phytosanitary inspection in section 5.2. There it is concluded (on page 17) that "grading and inspection procedures are effective in removing fruit with visible lesions." However, the model in Appendix 1 concludes that there is potential for symptomatic fruit to be shipped to citrus-producing states, even with inspection procedures in place.* (Reviewer 1)
Response: To include the discussion of the model before the discussion of the risk management options would be a bit of a *non sequitur*, since the stated purpose of the model is to help evaluate the phytosanitary inspection measures used in the proposed risk management options. Section 5.2 discusses the current packinghouse inspection process, not the APHIS phytosanitary inspection analyzed by the model. The conclusion that the grading and inspection procedures are effective in removing fruit with visible symptoms refers to the packinghouse staff's grading and inspection processes. Minor revisions have been made to the text of the risk management analysis to emphasize this distinction.

Comment: *APHIS concludes that a phytosanitary inspection at the packinghouse is an effective measure to detect fruit with Xac symptoms and reduce the likelihood that fruit with symptoms are shipped.' That may be true, but the model in Appendix 1 suggests that some symptomatic fruit will likely still get through and be shipped. As it is, this leaves conflicting conclusions in different parts of the document.* (Reviewer 1)
Response: The conclusion that inspection is effective is not incongruent with the prediction of the model that some fruit with visible symptoms may escape detection. The conclusion is not that inspection is 100 percent effective. For that to be the case, 100 percent of the fruit would have to be inspected with 100 percent efficiency. Surely something less could still be considered "effective."

2.7 Were the quantitative methodologies used in this assessment applied appropriately to achieve the objectives of the inspection efficacy assessments?

Comment: *The authors use graphs with a pseudo-perspective effect (Figures 9-11 through 9-15) to present some of their results. This goes against accepted practice for the design of effective data graphics.…These same results can be presented in a more informative way in a simple untilted pie chart, or even in a table*. (Reviewer 3)
Response: We acknowledge that the figures were distracting, and have made the recommended changes in the final document.

Comment: *I would have liked to see more on the pros and cons of the different risk management options in light of the results of the risk assessment modeling effort.* (Reviewer 3)
Response: The quantitative model indicated that, under the unlimited distribution included in Option 2, there is a statistical likelihood that, under Option 2, a very small number of commercially packed fruit with visible symptoms of Xac will escape undetected and potentially reach citrus-producing States. Because Options 3 and 4 include a prohibition on the distribution of fruit to citrus-producing States (except tangerines, in the case of Option 3), we qualitatively determined that the risk presented by those options would be less than that presented by Option 2. However, because we lack the data to quantify the amount of fruit that would be shipped illegally to citrus-producing States, we were unable to model direct comparisons between Option 2 and Options 3 and 4.

Comment: *I would like to see more analysis to back up the statement that "a packinghouse-based inspection could ensure the same level of phytosanitary security as the current grove certification approach" (Section 7.5). Perhaps this analysis is in another document; still, any analysis comparing a grove-based strategy with a packinghouse-based strategy would have to reconcile that comparison with the discussion of uncertainty concerning the efficacy of grove inspections as compared to packinghouse culling on p. 90.*

Response: There was no formal analysis done to back up the statement that "a packinghouse-based inspection could ensure the same level of phytosanitary security as the current grove certification approach" (Section 7.5). The statement was based on our experience under the regulations requiring a grove inspection, in which packinghouse inspections of fruit that had originated from groves that had been inspected and found to be free of canker nevertheless found fruit with visible canker lesions, and our general experience with packinghouse inspection as a risk mitigation. However, to avoid confusion, the document now states instead that a packinghouse-based inspection can provide an appropriate level of phytosanitary protection, a conclusion supported by our formal analysis.

2.8 Do the data and the evidence support the range of risk management options presented?

Comment: *In general, yes. However, as mentioned above in my answer to question (2), I would like to have seen some discussion of the how the climatic differences between the other five citrus-producing states might have influenced decisions to allow or prohibit shipments of commercially-packed citrus fruit to those states individually. On the other hand, perhaps the authors were required to consider only mutually-exclusive risk management options; if that's the case, this criticism is irrelevant* (Reviewer 3)
Response: If natural climate were the only risk factor that distinguished the States, then we could qualitatively conclude that potential susceptibility to citrus canker is less in California than in Louisiana or Texas. However, variations in the amount of rainfall within each State, and the use of irrigation in areas with less rainfall, serve to blur that conclusion. These factors, along with the fact that we cannot limit distribution to any area less than an entire State, would make it difficult to model and evaluate risk management options separately for each citrus-producing State.

2.9 Is the logic behind the choice (or rejection) of risk management options clearly stated and supported by data and evidence presented?

Comment: *…the logic presented for rejecting Options 1-3 would seem to apply to Option 4… APHIS can not rule out that infected fruit could reach citrus-producing states through illegal movement of citrus from non-citrus producing states. In accepting Option 4, the document states (page 35) that "Option 4 compensates for uncertainty in the rate of illegal fruit movement by requiring a disinfectant treatment and phytosanitary inspection in addition to the distribution restriction." This is no different from what Option 2 requires … Unless I missed something, Option 4 presents no additional mitigation to assure that infected fruit will not be shipped out of Florida … under Option 4, movement to a citrus-producing state would have to occur by illegal shipping, which does make it less likely to occur than under Option 2, where infected fruit could be shipped directly (legally) to citrus-producing states. However, APHIS says they can not quantify the frequency of such illegal shipments, so they have no quantitative reason to reject this as a possibility… It is not unreasonable to think that illegal shipments could occur …. into citrus-producing areas of California. My recommendation is that the analysis should reject Option 4 with the same logic as used to reject the other options.* (Reviewer 1)
Response: The quantitative model indicated that, under the unlimited distribution included in Option 2, there is a statistical likelihood that, under Option 2, a very small number of commercially packed fruit with visible symptoms of Xac will escape undetected and potentially reach citrus-producing States. Because Option 4 includes a prohibition on the distribution of fruit to citrus-producing States, we qualitatively determined that the risk presented by those options would be less than that presented by

Option 2, as the volume of fruit moved to citrus-producing States would be less if moving fruit to citrus-producing States was illegal. However, because we lack the data to quantify the amount of fruit that would be shipped illegally to citrus-producing States, we were unable to model direct comparisons between Option 2 and Option 4.

Illegal movement is a potential problem under any regulatory approach. To ensure compliance with regulatory requirements and distribution restrictions, APHIS will routinely monitor wholesalers and fresh fruit markets in commercial citrus-producing States and distribution routes bound for commercial citrus-producing States to ensure that Florida citrus fruit does not unlawfully enter U.S. commercial citrus producing States. This monitoring will be conducted primarily by APHIS' Smuggling Interdiction and Trade Compliance program, which works with Federal, State and local cooperators to interdict smugglers, close illegal pathways, and prevent the unlawful entry and distribution of prohibited agricultural products that may harbor harmful, exotic plant and animal pests, disease, or invasive species. We have added information about these activities to the risk management analysis. The packinghouse measures of disinfection and APHIS inspection required under Option 4 ensure that even if a given shipment were illegally moved to a prohibited State, the shipment would have a low likelihood of containing fruit with the potential to cause an outbreak of citrus canker disease.

Comment: *I support this option* [Option 2] *as being prudent and realistic. Any commercial fruit shipped to citrus-producing states is unlikely to result in the introduction of the disease into those states...In addition, it is highly unlikely that canker would become established and become a production problem in California or Arizona. Even though the possibility would be greater for Texas, I doubt that canker would be a serious problem even there. Canker could be serious in Louisiana, but introduction there is much more likely on living plants moved from Florida than on commercial fruit.* (Reviewer 2)
Response: We agree with the commenter that commercially packed citrus fruit is an unlikely pathway for the spread of citrus canker disease; however, the evidence is not currently sufficient to support a determination that fresh citrus fruit produced in a Xac-infested grove cannot serve as a pathway for the introduction of Xac into new areas. Therefore, we feel that the prohibition on shipments to citrus producing States is justified.

Comment: *The risk assessment itself isn't really formulated in such a way as to allow us to choose between options 2 and 4.* (Reviewer 3)

Response: The reviewer is correct that the quantitative assessment is not set up to allow us to choose between Options 2 and 4. The main reason we did not quantitatively differentiate between Options 2 and 4 is that even though we quantified Option 2, we could not credibly quantify Option 4; quantifying Option 4 would require credible data on the potential movement of Florida fruit from non-citrus producing States to citrus producing States. We know that APHIS will routinely monitor wholesalers and fresh fruit markets in commercial citrus-producing States and distribution routes bound for commercial citrus-producing States to ensure that Florida citrus fruit does not unlawfully enter U.S. commercial citrus producing States. Therefore, under Option 4, the amount of

Florida citrus moved illegally to citrus producing states from non citrus producing states will be much less than the legal citrus moved under Option 2. As a result, we can qualitatively state that Option 4 is much less likely than Option 2 to cause citrus canker establishment in citrus producing States.

3 Summary

The three reviewers agreed that the analysis presented in the document clearly characterizes the potential of commercially packed citrus fruit as a pathway for the introduction and spread of citrus canker. Each reviewer identified additional areas to address in the analysis, for example, the impact of citrus leaf miner, the risk involved in movement of the citrus canker bacterium by means other than commercially packed citrus fruit, and the implications of climatic differences in the potential susceptibility of other citrus-growing States to novel citrus canker disease infestations. APHIS has addressed the concerns by changes to the final RMA or by providing clarification in this response.

The three reviewers concurred that the methodology used was appropriate for the analysis and that important assumptions were identified and uncertainties clearly stated. The reviewers agreed that the document was generally well organized and clearly written. One reviewer offered suggestions for improving the organization of the document. One of the reviewers offered a few criticisms of the risk assessment, including the use of pseudo-perspective graphs to present some of the results of the analysis, the lack of information on the pros and cons of the different risk management options in light of the risk assessment modeling effort, and the failure of the risk assessment to address the probability of establishing new citrus canker infestations through transport of commercially packed fruit.

The three reviewers think that the five risk management options presented were logical ones to consider given the evidence available. Each reviewer also commented on the logic behind the choice (or rejection) of the five risk management options.

4 References

Christiano, R.S.C., Dalla Pria, M., Jesus Junior, W.C., Parra, J.R.P., Amorim, L. and Bergamin Filho, A. (2007). "Effect of citrus leaf-miner damage, mechanical damage and inoculum concentration on severity of symptoms of Asiatic citrus canker in Tahiti lime." Crop Protection **26**: 59-65

Gottwald, T.R. and L.W. Timmer (1995). "The efficacy of windbreaks in reducing the spread of citrus canker caused by *Xanthomonas campestris* pv. *citri*." Tropical Agriculture **72**(3): 194-201.

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Sheryl Cates Catherine Viator, "Citrus Canker Peer Review: Final Report",
November 2007, RTI International Health, Social, and Economics Research, Research Triangle Park, NC. (available at
http://www.aphis.usda.gov/peer_review/peer_review_agenda.shtml)