Technical Assistance for Specialty Crops (TASC)

Agreement # 2014-15

Activity Code: T14GXCDPB1

4th Quarter Year 4: July 01, 2014 – June 30, 2015
Product: Commodities Requiring Quarantine and Preshipment Fumigation
Cooperator: California Dried Plum Board

Spencer Walse

Which Year of the Project is this the Final Report for (highlight year)?: Year 1 2 3 **4** 5

I. Project Title: "Retaining export and food security of U.S. specialty crops: low-emission methyl bromide fumigations for quarantine and pre-shipment uses"

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III. Project Activity/Activity Description: The goal of this project is to retain critical export of specialty crops that have quarantine and pre-shipment (QPS) fumigation requirements by developing a commercially viable, cost efficient and effective process to contain, destroy, or recapture/reuse methyl bromide (MB) and its alternatives following postharvest fumigations. The California Dried Plum Board (CDPB) manages this research and updates other specialty crop industries as work progresses to keep methyl bromide and its replacements out of the atmosphere following postharvest fumigation. The research for Year 1 was focused on determining whether novel nanomaterial sorbents outperform activated carbon, the sorbent used in existing MB capture systems for QPS. The research for Year 1 was focused on determining what catalysts maximize the destruction of fumigants in QPS applications. The research for Year 3 focused on the evaluation of low-energy combustion with direct comparison to sorption- and catalyst-based approaches.

IV. Trade Barrier/Constraint:

Primary Target Markets: Specialty crop exports with QPS requirement of MB fumigation

Quarantine and pre-shipment (QPS) chamber fumigations with MB are demanded by trade partners for many specialty crop exports. MB is used in nearly all of these QPS scenarios because it is the only fumigant proven to achieve insect pest control at probit 9 mortality levels (i.e. > 99.9986%), which is needed to guarantee food security. This history of effectiveness has protected MB, a well-documented stratospheric ozone depletor, from environmental regulation in its QPS capacity thus far.

However, since the great majority of chambers release spent MB directly into the atmosphere, the QPS export of specialty crops has a marked potential to be limited by new chemical regulations on air-quality (e.g., greenhouse gases, VOCs, etc). If there is regulatory expansion to restrict fumigant emissions in the U.S., similar to the trend already observed in European and Australian environmental policy, the cost of regulatory compliance could seriously impact the economics of specialty crop production, which relies heavily on the profit margin of exports, including many with QPS requirements for MB fumigation.

V. Partner Organizations and their role in the RESEARCH activity:

San Joaquin Valley Agricultural Science Center (SJVASC) (Walse, Hall), Connecticut Agricultural Experiment Station (Pignatello), Yale University (Mitch), University of California-Berkeley (Zilberman), James F. Thompson (Consultant), James G. Leesch (Consultant), and USDA-APHIS-PPQ (Wood). Please review proposal for specific research activities.

VI. Market Assessment Update:

Effective March 18, 2010, the EU announced a total prohibition on the use of MB, including that for QPS fumigations, which reinforces the need for immediate research in the area of designing chamber fumigations to operate with little, or no, atmospheric emissions.

VII. Activity Outcomes:

Research activity has progressed as planned in accordance with the diagnostic performance measures and corresponding timeline as outlined in the original FY2010 proposal.

Overall project objectives (a-e) and Performance Measures for Year 4

a) Develop novel sorbents, destructive catalysts, and combustion techniques to eliminate the atmospheric input of the most widely used QPS fumigant, MB.

b) Engineer low-emission systems for alternative fumigants to enhance potential for QPS use.

c) **Scale promising technologies from laboratory-, through pilot-, and into commercial-size chamber fumigations with APHIS and specialty crop-specific industry input (i.e., confirm technical feasibility).**

d) **Study the economics of commercial-scale chamber fumigations that have reduced or negligible atmospheric impact.**

e) Technology transfer, extension, and education. We will work collaboratively with specialty crop stakeholders, APHIS, and air quality agencies to implement low-emission chamber fumigations that are based on outcomes of the project

Year 4 Performance Measures and Estimated Timeline:

Year 4. Scale what is learned in years 1-3 from lab-, through pilot-, to commercial- size fumigations.

Benchmarks were met, as illustrated by the tables below.

Objective(s)	Timeline elements
a – e	Finish and report tests from year three.
c	Design stacking and airflow techniques to maximize the efficiency of low-emission postharvest fumigations for pilot- , and then, commercial-size chamber fumigations.
c, d	Explore "recycling" elements for fumigant reuse and sorbent regeneration in commercial-scale chambers and conduct corresponding economic assessments.
a-e	Conduct second workshop at SJVASC to translate results to industry and government.
e	Present our results, and associated economic analyses, in professional journals, conferences, and/or meetings.
f	Finish lab- through pilot- transitions and continue pilot- through commercial-scale up.

All Year 3) Benchmarks were met, as illustrated by the tables below.

Year 3. Evaluate low-energy combustion of QPS fumigants; directly compare with sorption- and catalyst based approaches.

Objective(s)	Timeline Elements
a-e	Finish and report tests from previous years. **– Researchers published peer-reviewed manuscripts based on research conducted in Year 1, Year2, and Year 3 of this project:** C. Chen; J. J. Pignatello "Catalytic oxidation for elimination of methyl bromide fumigation emissions using cerium catalysts"*J.App. Cat. B* 2013 (142-143), 785-794. Y. Yang; Y. Li, S.S. Walse, W.A. Mitch "Destruction of Methyl Bromide Sorbed to Activated Carbon by Thiosulfate and Electrolysis" *Environ. Sci. Technol.* 2015, 49, 4515−4521 Y. Li, J. Kemper, G. Datuin, A. Akey, W.A. Mitch, R. Luthy "Reductive Degradation of Chloropicrin by an Activated Carbon-Based Semi-Passive Electrode System " *Environ. Sci. Technol.* 2015, in press *Hall, W.A.*, Bellamy, D.E., and Walse, S.S. Activated carbons from end-products of tree fruit and tree nut production as sorbents for removing methyl bromide in ventilation effluent from postharvest chamber fumigations. J. Agric. Food Chem., accepted March 2, 2015 *J. Agric. Food Chem.*, 2015, *63* (12), pp 3094–3103
c	Design stacking and airflow techniques to maximize the efficiency of low-emission postharvest fumigations for pilot- , and then, commercial-size chamber fumigations. **The results of this research, which focused primarily on the measuring the concentration of fumigants respective to scale-dependent airflows, were reported in:** Activated carbons from end-products of tree fruit and tree nut production as sorbents for removing methyl bromide in ventilation effluent from postharvest chamber fumigations. J. Agric.

	Food Chem., accepted March 2, 2015 *J. Agric. Food Chem.*, 2015, *63* (12), pp 3094–3103
c, d	Explore "recycling" elements for fumigant reuse and sorbent regeneration in commercial-scale chambers and conduct corresponding economic assessments. **Researchers published two articles on this topic:** **Hall, W.A.**, and Walse, SS. MB Release from Activated Carbon and the Soil / Water / Carbon Interface, American Chemical Society National Meeting and Exposition, San Francisco, CA, August 8-14, 2014. (Conference Proceedings). **Hall, W.A.** and Walse, S.S Solid Phase Microextraction for the Quantification of Methyl Bromide, Proceedings of Methyl Bromide Alternatives and Emissions Research Conference, San Diego, CA, November 4-6, 2013. (Conference Proceedings). Y. Li, J. Kemper, G. Datuin, A. Akey, W.A. Mitch, R. Luthy "Reductive Degradation of Chloropicrin by an Activated Carbon-Based Semi-Passive Electrode System " *Environ. Sci. Technol*. 2015, in press
a-e	Conduct workshops (at SJVASC or MBAO) to translate results to industry and government. – All researchers presented outcomes of this research at the International Methyl Bromide Alternatives Conference in Orlando, FL November 4&5, 2014 **(project collaborators noted in bold)** https://mbao.org/static/docs/confs/2014-orlando/005-14ConfProgram.pdf Postharvest Session II: Submitted Papers Location: Galaxy 2, 3, 4 Title: Fumigation Moderator: Wes Schilling 8:00-8:20 Najar-Rodriguez, Adriana (26) - Ethanedinitrile: A Potential Methyl Bromide Alternative to Control Quarantine Insects Infesting Logs and Timber in New Zealand 8:20-8:40 Najar-Rodriguez, Adriana (27) - Toxicity of Reduced Methyl Bromide Rates to Quarantine Insects Associated with New Zealand Export Logs 8:40-9:00 Thoms, Ellen (28) - Update on Profume® Gas Fumigant (Sulfuryl Fluoride) **9:00-9:20 Walse, Spencer (29) - Postharvest Treatment Research at USDA-ARS: Stored Product Fumigation** **9:20-9:40 Walse, Spencer (30) - Update on Cylinderized Phosphine Research at USDA-ARS: Key Efficacy, Residue and Regulatory Data** **9:40-10:00 Hall, Wiley (31) - Analytical Methodology for the Detection of Fumigants at the SJVASC** Postharvest Session III: Submitted Papers Location: Galaxy 2, 3, 4 Title: Non-fumigant Alternatives Moderator: Wiley Hall 10:30-10:50 Hennessey, Mike (32) - Aphis Methyl Bromide Alternatives Methods Development Completed 2014 10:50-11:10 Johnson, Judy (33) - Non-Chemical Treatments for Dried Fruits and Nuts: A Retrospective 11:10-11:30 Schilling, Wes (34) - Development Of Food Grade Coatings to Prevent Mite Infestation On Dry Cured Ham **11:30-11:50 Zilberman, David (67) - The Economics of Adoption and Cancellation: Lessons from Methyl Bromide** Postharvest Session V: Submitted Papers Location: Galaxy 2, 3, 4 Title: Emissions Control Moderator: Spencer Walse **3:30-3:50 Hall, Wiley (36) – The Recapture and Reuse of Methyl Bromide on Activated Carbon** 3:50-4:10 Joyce, Peter (37) – Commercial Scale Q/PS Methyl Bromide Emissions Control **4:10-4:30 Mitch, William (38) – Destruction of Methyl Bromide on Activated Carbon Using Thiosulfate or Electricity** **4:30-4:50 Swords, Peter (39) – F.A.S.T. System: Fumigant Disposal and Scrubbing Treatment** **4:50-5:10 Vasireddy, Sivakumar (40) - Enhanced Catalysts for Combustion of CH3Br: MOX – CEO2 (M = Mn, Co)**

e	Present our results, and associated economic analyses, in professional journals, conferences, and/or meetings. In addition to the material presented above, other presentations include: Walse, S.S. "Update on postharvest treatment research for dreid fruit and tree nuts" California Dried Plum Board, Sacramento, CA. December 10, 2014. Walse, S.S. "Postharvest fumigation research at USDA-ARS: stored products" The Industrial Fumigant Company, Kansas City, MO. February 12, 2015. Walse, S.S. "Postharvest fumigation research at USDA-ARS: stored products" Grain Elevators and Processors Association, St. Louis, MO. February 24, 2015. Walse, S.S. California Walnut Board, Grades and Standards Committee meeting, Sacramento, CA, March 9, 2015. . Walse, S.S. "Postharvest treatment research at USDA-ARS" Annual Pesticide Review Conference. Dried Fruit and Nut Association of California Yuba City, CA. May 7, 2015.
f	Finish lab- through pilot- transitions and continue pilot- through commercial-scale up. **Lab- through pilot-has been completed, with completion of commercial planned for Year 5.**