Question 5. What scientific information or additional information supports your submittal?

References. Please note that the reference numbers listed below match the corresponding citations used throughout our responses to Question 4.

1. **California Department of Pesticide Regulation. Pesticide Use Annual Report 2023 Data Summary. Sacramento, CA: California Department of Pesticide Regulation, 2025.**

   https://www.cdpr.ca.gov/wp-content/uploads/2025/08/2023_pur_annual_report.pdf

   Description: DPR's annual pesticide-use report documents statewide agricultural pesticide use in 2023. It defines fumigants as volatile gas pesticides capable of penetrating soil, stored products, structures, and other sites, and provides statewide use trends for fumigant active ingredients. The underlying 2023 use data show approximately 8.6 million pounds of metam-potassium, 8.5 million pounds of chloropicrin, 7.0 million pounds of 1,3-dichloropropene, and 2.8 million pounds of metam-sodium used in California.

2. **Simmons, Christopher, and Janet Broome. Fumigant Use in California and an Assessment of Available Alternatives: Phase I Report on 1,3-D and Chloropicrin. California Council on Science and Technology. Commissioned by the California Department of Pesticide Regulation. March 13, 2025.**

   https://ccst.us/reports/fumigant-use-in-california-and-an-assessment-of-available-alternatives-phase-i-report-on-13-d-and-chloropicrin/

   Description: This independent, peer-reviewed assessment commissioned by DPR examines 1,3-D and chloropicrin, their health and environmental concerns, California use, and alternatives. The report discusses the inherent volatility and atmospheric emissions of fumigants, exposure of nearby communities and workers, potentially vulnerable populations, deficiencies in understanding cumulative and synergistic effects, and available nonfumigant alternatives.

3. **Ashworth, Daniel J., and Scott R. Yates. "Surface Irrigation Reduces the Emission of Volatile 1,3-Dichloropropene from Agricultural Soils." Environmental Science & Technology 41, no. 7 (2007): 2231–2236. DOI: 10.1021/es062642d.**

   https://pubs.acs.org/doi/10.1021/es062642d

   Description: This peer-reviewed study investigated volatilization of the soil fumigant 1,3-D under realistic soil conditions. The authors characterize 1,3-D as a VOC-containing fumigant released from soil to the atmosphere and found that surface irrigation reduced emissions by roughly half in the tested soil columns. It provides independent evidence of the atmospheric-emission pathway associated with this highly volatile soil fumigant.

4. **Gao, Suduan, Thomas J. Trout, and Sally Schneider. "Evaluation of Fumigation and Surface Seal Methods on Fumigant Emissions in an Orchard Replant Field." Journal of Environmental Quality 37, no. 2 (2008): 369–377. DOI: 10.2134/jeq2007.0088.**

   https://doi.org/10.2134/jeq2007.0088

   Description: This peer-reviewed California field study measured emissions of both 1,3-D and chloropicrin following soil fumigation. The authors identify fumigant VOC emissions as contributing to formation of ground-level ozone and discuss reducing emissions as important for worker and bystander exposure as well as air pollution.

5. **California Department of Pesticide Regulation. Air Monitoring Network Results for 2023. Sacramento, CA: California Department of Pesticide Regulation, 2024.**

   https://www.cdpr.ca.gov/wp-content/uploads/2024/12/2023_amn_results-2024.pdf

   Description: DPR monitored pesticides in Oxnard, Shafter, Santa Maria, and Watsonville. Four fumigants were detected at quantifiable concentrations: 1,3-D, chloropicrin, methyl bromide, and MITC, demonstrating ongoing ambient-air exposure pathways in California agricultural communities.

6. **California Department of Pesticide Regulation. "DPR Statement on CDFA Laboratory Error." February 13, 2025; updated February 25, 2025.**

   https://www.cdpr.ca.gov/2025/02/13/dpr-statement-on-cdfa-laboratory-error/

   Description: CDFA informed DPR that a laboratory calculation error had caused methyl bromide and 1,3-D concentrations to be underreported in DPR air samples collected between February 2011 and November 2024. After correction, DPR identified additional historical 1,3-D readings that exceeded screening levels or regulatory targets.

7. **California Office of Environmental Health Hazard Assessment. Updated Recommendation to Mitigate Cancer Risk for Occupational Bystanders from 1,3-Dichloropropene. June 11, 2024.**

   https://oehha.ca.gov/sites/default/files/media/downloads/proposition-65/document/memo13-d07124pdf.pdf

   Description: OEHHA developed health-based recommendations intended to reduce occupational-bystander cancer risk from 1,3-D to one in 100,000. OEHHA calculated that an average working-lifetime exposure concentration of 0.21 ppb corresponds to that target risk. The memo reports that annual-average ambient concentrations measured during 2017–2022 in Parlier, Shafter, and Delhi were 1.112, 0.630, and 0.315 ppb, respectively, and states that these values significantly exceeded 0.21 ppb. OEHHA noted that these monitoring data predated DPR's January 2024 non-occupational-bystander regulation and expected concentrations to be lower under the newer controls.

8. **California Department of Pesticide Regulation. "Statement From the California Department of Pesticide Regulation on 1,3-D Monitoring Data and Regulatory Review." July 8, 2026.**

   https://www.cdpr.ca.gov/2026/07/08/statement-from-the-california-department-of-pesticide-regulation-on-13-d-monitoring-data-and-regulatory-review/

   Description: DPR reported that the annual-average 1,3-D concentration at its Parlier monitoring site reached 0.35 ppb in 2025, above DPR's 0.27-ppb regulatory monitoring threshold. The exceedance triggered additional scientific review of monitoring trends, pesticide-use data, and whether additional regulatory action may be warranted. DPR emphasizes that 0.27 ppb is a regulatory evaluation trigger rather than its health-effects threshold.

9. **Californians for Pesticide Reform. Cancer-Causing Pesticide 1,3-Dichloropropene (1,3-D) in California Air: DPR's Proposed Regulation Fails to Protect Public Health. January 2023.**

   https://www.pesticidereform.org/wp-content/uploads/2023/01/13-D-Report-Jan_2023-FINAL.pdf

   Description: This report compiles California 1,3-D monitoring and use information. It reports that a one-day concentration of 20.8 ppb measured at Sequoia Elementary School in Shafter in January 2020 originated from a 1,3-D application 7.5 miles away, according to DPR. The report cites an analysis by DPR scientist Minh Pham, "A summary of notable detections at Shafter AMN site in 2020," which was not publicly available on DPR's website. The distance attribution is therefore documented here through CPR's citation to DPR's underlying analysis.

10. **California Department of Pesticide Regulation. Air Monitoring Network Results for 2024. Sacramento, CA: California Department of Pesticide Regulation, 2025.**

    https://www.cdpr.ca.gov/wp-content/uploads/2025/11/2024_amn_report_2025.pdf

    Description: DPR's 2024 Air Monitoring Network measured pesticides in Oxnard, Santa Maria, Shafter, and Watsonville. MITC was detected at quantifiable concentrations in Oxnard, Santa Maria, and Shafter and as a trace detection in Watsonville. No MITC concentration exceeded DPR's acute, subchronic, or chronic screening levels, although the highest concentrations measured in Shafter reached approximately 85.3% of the subchronic screening level and 83.3% of the chronic screening level.

11. **U.S. Environmental Protection Agency. Reregistration Eligibility Decision for Methyldithiocarbamate Salts—Metam Sodium/Potassium and MITC. Office of Pesticide Programs. July 9, 2008.**

    https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1000VXU.TXT

Description: EPA's reassessment evaluated inhalation risks associated with metam-sodium, metam-potassium, and their major volatile breakdown product MITC. EPA concluded that MITC inhalation exposure from soil fumigation could pose risks of concern to bystanders, workers, and handlers and required extensive additional mitigation, including buffer zones, posting, emergency preparedness, monitoring, respiratory protection, fumigant management plans, and other controls.

12. **California Department of Pesticide Regulation. Correlating Agricultural Use with Ambient Air Concentrations of Methyl Isothiocyanate During the Period of 2011–2014.**

    https://www.cdpr.ca.gov/wp-content/uploads/2024/10/methyl_isothiocyanate.pdf

    Description: DPR examined relationships between ambient MITC concentrations and reported applications of MITC-generating pesticides around monitoring stations in Salinas, Shafter, and Ripon. DPR found MITC detections during weeks in which no MITC-precursor use was reported within five miles, particularly in Salinas and Shafter, and concluded that some detections may have resulted from applications farther than five miles away. The analysis also documented a Salinas MITC detection four days after an application approximately 4.75 miles from the monitoring station.

13. **Li, LinYing, Bruce B. Johnson, and Randy Segawa. "Empirical Relationship between Use, Area, and Ambient Air Concentration of Methyl Bromide." Journal of Environmental Quality 34, no. 2 (2005): 420–428. DOI: 10.2134/jeq2005.0420a.**

    https://pubmed.ncbi.nlm.nih.gov/15758093/

    Description: This peer-reviewed California study examined the relationship between reported methyl-bromide use and measured ambient-air concentrations. The strongest relationship occurred when pesticide use was aggregated over a 7 × 7-mile area surrounding the monitoring location, providing evidence that community-air concentrations of a volatile fumigant can be influenced by applications over a broad surrounding agricultural area.

14. **Zaunbrecher, Virginia, Dale Hattis, Ron Melnick, Susan Kegley, Timothy Malloy, and John Froines. Exposure and Interaction: The Potential Health Impacts of Using Multiple Pesticides. UCLA Sustainable Technology & Policy Program, February 17, 2016.**

    https://law.ucla.edu/sites/default/files/PDFs/Publications/Emmett%20Institute/_CEN_EMM_PUB_Exposure%20and%20Interaction.pdf

    Description: This UCLA analysis uses 1,3-D, chloropicrin, and metam-sodium as a case study of pesticide-mixture exposure. It identifies biologically plausible mechanisms through which combined exposures could affect common detoxification and antioxidant pathways, oxidative stress, DNA damage, mutagenicity, and DNA repair. The report does not claim that specific synergistic health effects have been proven in humans; rather, it identifies mixture effects as an important unresolved regulatory concern.

15. **Gunier, Robert B., Asa Bradman, Rosemary Castorina, Nina T. Holland, Dylan Avery, Kim G. Harley, and Brenda Eskenazi. "Residential Proximity to Agricultural Fumigant Use and IQ, Attention and Hyperactivity in 7-Year Old Children." Environmental Research 158 (2017): 358–365. DOI: 10.1016/j.envres.2017.06.036.**

https://pmc.ncbi.nlm.nih.gov/articles/PMC5557382/

Description: This CHAMACOS study examined children living in California's Salinas Valley and estimated residential proximity to methyl bromide, chloropicrin, metam-sodium, and 1,3-D applications during pregnancy and childhood. Greater childhood proximity to methyl bromide and chloropicrin use was associated with lower Full-Scale IQ at age seven. The authors cautioned that the findings require confirmation in larger studies.

16. **Gemmill, Alison, Robert B. Gunier, Asa Bradman, Brenda Eskenazi, and Kim G. Harley. "Residential Proximity to Methyl Bromide Use and Birth Outcomes in an Agricultural Population in California." Environmental Health Perspectives 121, no. 6 (2013): 737–743. DOI: 10.1289/ehp.1205682.**

https://pmc.ncbi.nlm.nih.gov/articles/PMC3672911/

Description: This CHAMACOS study evaluated pregnancies in California's Salinas Valley. Greater residential proximity to methyl-bromide use during the second trimester was associated with indicators of restricted fetal growth, including lower birth weight, shorter birth length, and smaller head circumference. The observational study does not establish causation but identifies pregnancy and fetal development as potential areas of concern.

17. **Gharibi, Hamed, Marcela R. Entwistle, Donald Schweizer, Pooya Tavallali, Chia Thao, and Ricardo Cisneros. "Methyl-Bromide and Asthma Emergency Department Visits in California, USA from 2005 to 2011." Journal of Asthma 57, no. 11 (2020): 1227–1236. DOI: 10.1080/02770903.2019.1645167.**

https://pubmed.ncbi.nlm.nih.gov/31311358/

Description: This bidirectional case-crossover study evaluated asthma emergency-department visits in Central and Southern California in relation to ambient methyl-bromide concentrations. The authors reported positive associations among children ages 6–18, Hispanic patients, and non-Hispanic Black patients, although not among every population group. The findings are appropriately characterized as suggestive rather than definitive evidence of causation.

18. **Gharibi, Hamed, Marcela R. Entwistle, Donald Schweizer, Pooya Tavallali, and Ricardo Cisneros. "The Association between 1,3-Dichloropropene and Asthma Emergency Department Visits in California, USA from 2005 to 2011: A Bidirectional-Symmetric Case Crossover Study." Journal of Asthma 57, no. 6 (2020): 601–609. DOI: 10.1080/02770903.2019.1590596.**

https://pubmed.ncbi.nlm.nih.gov/30938205/

Description: This study examined asthma emergency-department visits and short-term ambient 1,3-D concentrations in Central and Southern California. The authors reported increased odds of asthma emergency-department visits during particular seasons and among several demographic groups. Exposure-assessment limitations and the observational design mean the findings should be considered suggestive rather than definitive.

19. **Lee, Soo-Jeong, Louise Mehler, John Beckman, Brienne Diebolt-Brown, Joanne Prado, Michelle Lackovic, Justin Waltz, Prakash Mulay, Abby Schwartz, Yvette Mitchell, Stephanie Moraga-McHaley, Rita Gergely, and Geoffrey M. Calvert. "Acute Pesticide Illnesses Associated with Off-Target Pesticide Drift from Agricultural Applications: 11 States, 1998–2006." Environmental Health Perspectives 119, no. 8 (2011): 1162–1169. DOI: 10.1289/ehp.1002843.**

    https://pmc.ncbi.nlm.nih.gov/articles/PMC3237344/

    Description: This multistate surveillance study identified 2,945 cases associated with 643 agricultural pesticide-drift events. Although soil fumigants were involved in only about 8% of events, they accounted for approximately 45% of all illness cases and 61% of nonoccupational cases; five of the ten largest incidents involved California metam-sodium or chloropicrin applications. The data largely predate stronger fumigant controls and should not be treated as estimates of current illness rates.

20. **Barry, Terrell, Michel Oriel, MaryLou Verder-Carlos, Louise Mehler, Susan Edmiston, and Michael O'Malley. "Community Exposure Following a Drip-Application of Chloropicrin." Journal of Agromedicine 15, no. 1 (2010): 24–37. DOI: 10.1080/10599240903389599.**

    https://pubmed.ncbi.nlm.nih.gov/20390729/

    Description: This peer-reviewed investigation examined a 2005 chloropicrin exposure incident near residential neighborhoods in Salinas. Investigators identified 324 residents with symptoms possibly or probably related to exposure; cases occurred between 0.36 and 2.89 miles from the treated field. The study provides direct evidence that fumigant emissions can move well beyond a treated field and cause acute community health effects.

21. **Barreau, Tracy, Sumi Hoshiko, Rick Kreutzer, Svetlana Smorodinsky, and John Talarico. "Sulfuryl Fluoride Poisonings in Structural Fumigation, a Highly Regulated Industry—Potential Causes and Solutions." International Journal of Environmental Research and Public Health 16, no. 11 (2019): 2026. DOI: 10.3390/ijerph16112026.**

    https://pmc.ncbi.nlm.nih.gov/articles/PMC6603922/

    Description: California public-health researchers reviewed sulfuryl-fluoride poisonings associated with structural fumigation. The paper documents mechanisms through which exposure can occur despite extensive regulation and describes serious effects including respiratory injury, seizures, neurological injury, and death at sufficiently high exposures.

22. **Zeinali, Mazyar, Laura L. McConnell, Cathleen J. Hapeman, Anh Nguyen, Walter F. Schmidt, and Cody J. Howard. "Volatile Organic Compounds in Pesticide Formulations: Methods to Estimate Ozone Formation Potential." Atmospheric Environment 45, no. 14 (2011): 2404–2412. DOI: 10.1016/j.atmosenv.2011.02.015.**

https://doi.org/10.1016/j.atmosenv.2011.02.015

Description: This peer-reviewed study examined VOC constituents in pesticide formulations and methods for estimating their ozone-forming potential. The authors explain that pesticide VOCs can contribute to ground-level ozone and that VOC mass alone does not fully capture ozone-forming potential because compounds differ substantially in atmospheric reactivity.

23. **Sun, Haitong Zhe, Pei Yu, Changxin Lan, Michelle W. L. Wan, Sebastian Hickman, Jayaprakash Murulitharan, Huizhong Shen, Le Yuan, Yuming Guo, and Alexander T. Archibald. "Cohort-Based Long-Term Ozone Exposure-Associated Mortality Risks with Adjusted Metrics: A Systematic Review and Meta-Analysis." The Innovation 3, no. 3 (2022): 100246. DOI: 10.1016/j.xinn.2022.100246.**

https://pubmed.ncbi.nlm.nih.gov/35519514/

Description: This systematic review and meta-analysis standardized ozone exposure metrics across long-term cohort studies and reported increased risks of all-cause, respiratory, COPD, cardiovascular, and congestive-heart-failure mortality associated with higher warm-season ozone exposure. It supports the public-health significance of ground-level ozone but does not attribute those health outcomes specifically to pesticide-generated ozone.

24. **Kasdagli, Maria-Iosifina, Pablo Orellano, Román Pérez Velasco, and Evangelia Samoli. "Long-Term Exposure to Nitrogen Dioxide and Ozone and Mortality: Update of the WHO Air Quality Guidelines Systematic Review and Meta-Analysis." International Journal of Public Health 69 (2024): 1607676. DOI: 10.3389/ijph.2024.1607676.**

https://pmc.ncbi.nlm.nih.gov/articles/PMC11527649/

Description: This updated systematic review and meta-analysis evaluated long-term ozone exposure and mortality. It found an association between annual ozone exposure and respiratory mortality and rated the certainty of that evidence as high, providing strong support for the human-health importance of chronic ozone exposure.

25. **Papadimitriou, Vassilis C., et al. "Experimental and Theoretical Study of the Atmospheric Chemistry and Global Warming Potential of SO_2F_2." The Journal of Physical Chemistry A 112, no. 49 (2008): 12657–12666. DOI: 10.1021/jp806368u.**

https://doi.org/10.1021/jp806368u

Description: This peer-reviewed atmospheric-chemistry study experimentally measured sulfuryl fluoride's infrared absorption and atmospheric chemistry. Using an atmospheric lifetime of approximately 36 years, the authors calculated a 100-year global-warming

potential of approximately 4,780, providing independent scientific support for characterizing sulfuryl fluoride as an unusually climate-potent greenhouse gas.

26. **Mühle, Jens, et al. "Sulfuryl Fluoride in the Global Atmosphere." Journal of Geophysical Research: Atmospheres 114 (2009): D05306. DOI: 10.1029/2008JD011162.**

    https://doi.org/10.1029/2008JD011162

    Description: This peer-reviewed atmospheric-observation study measured sulfuryl fluoride globally and estimated a long atmospheric lifetime of approximately 36 ± 11 years. It also documented elevated atmospheric sulfuryl-fluoride concentrations associated with structural fumigation, demonstrating that fumigation emissions measurably enter the atmosphere.

27. **Spokas, Kurt, Dong Wang, and Rodney T. Venterea. "Greenhouse Gas Production and Emission from a Forest Nursery Soil Following Fumigation with Chloropicrin and Methyl Isothiocyanate." Soil Biology & Biochemistry 37, no. 3 (2005): 475–485. DOI: 10.1016/j.soilbio.2004.08.010.**

    https://doi.org/10.1016/j.soilbio.2004.08.010

    Description: This peer-reviewed field and laboratory study examined greenhouse-gas responses after soil fumigation with chloropicrin and MITC. Both fumigants significantly increased N_2O emissions compared with unfumigated controls, with effects still evident weeks after treatment. The study demonstrates that fumigation can alter soil processes in ways that increase emissions of an important greenhouse gas.

28. **Spokas, Kurt, Dong Wang, Rodney T. Venterea, and Michael J. Sadowsky. "Mechanisms of N_2O Production Following Chloropicrin Fumigation." Applied Soil Ecology 31, nos. 1–2 (2006): 101–109. DOI: 10.1016/j.apsoil.2005.03.006.**

    https://doi.org/10.1016/j.apsoil.2005.03.006

    Description: This peer-reviewed mechanistic study found that N_2O production increased approximately 12.6-fold following chloropicrin fumigation in the tested soil. The authors found that microbial activity accounted for most of the chloropicrin-induced N_2O production, helping explain the mechanism underlying the increased emissions.

29. **Fang, Wensheng, Dongdong Yan, Xianli Wang, Bin Huang, Xiaoning Wang, Jie Liu, Xiaoman Liu, Yuan Li, Canbin Ouyang, Qiuxia Wang, and Aocheng Cao. "Responses of Nitrogen-Cycling Microorganisms to Dazomet Fumigation." Frontiers in Microbiology 9 (2018): 2529. DOI: 10.3389/fmicb.2018.02529.**

    https://doi.org/10.3389/fmicb.2018.02529

    Description: This peer-reviewed study investigated dazomet fumigation in two different agricultural soils. Maximum N_2O-production rates increased approximately 9.9-fold in one soil and 30-fold in the other during the first ten days after treatment, demonstrating that fumigation-related N_2O effects are not limited to chloropicrin.

30. **Sharma, Asha, Margaret Reeves, and Calista Washburn. *Pesticides and Climate Change: A Vicious Cycle.* Pesticide Action Network North America, 2023.**

https://www.panna.org/wp-content/uploads/2023/02/202301ClimateChangeEngFINAL.pdf

Description: This scientific review examines the two-way relationship between pesticides and climate change. It reviews greenhouse-gas emissions associated with pesticide production, transport, use, and environmental effects, including the fossil-fuel basis and energy intensity of synthetic pesticide manufacture. The report notes that manufacturing 1 kilogram of pesticide requires, on average, about 10 times more energy than manufacturing 1 kilogram of nitrogen fertilizer, while also discussing greenhouse-gas emissions associated with both pesticide and fertilizer use. It further reviews evidence that climate change can increase pest pressures and pesticide use, creating a reinforcing "vicious cycle," and discusses pesticide reduction and agroecological approaches as climate and resilience strategies.

31. **Romanello, Marina, et al. "The 2024 Report of the Lancet Countdown on Health and Climate Change: Facing Record-Breaking Threats from Delayed Action." The Lancet 404, no. 10465 (2024): 1847–1896. DOI: 10.1016/S0140-6736(24)01822-1.**

https://pubmed.ncbi.nlm.nih.gov/39488222/

Description: This major peer-reviewed synthesis tracks the human-health effects of climate change globally. It documents rising heat exposure, heat-related mortality, drought, extreme-weather exposure, food insecurity, and other health threats. It does not concern fumigants specifically; it supports why an independently demonstrated contribution to climate forcing is relevant to a human-health prioritization framework.

32. **Holmes, Gerald J., Seyed Mojtaba Mansouripour, and Shashika S. Hewavitharana. "Strawberries at the Crossroads: Management of Soilborne Diseases in California Without Methyl Bromide." Phytopathology 110, no. 5 (2020): 956–968. DOI: 10.1094/PHYTO-11-19-0406-IA.**

https://pubmed.ncbi.nlm.nih.gov/32075499/

Description: This peer-reviewed review examines the history and management of soilborne disease in California strawberry production. The authors explain that fumigation allowed strawberries to be grown annually without rotation and that the California strawberry-production system subsequently evolved around fumigation as a cornerstone. The review discusses crop rotation, sanitation, resistant cultivars, and other systems-based approaches to disease management.

33. **Subbarao, K. V., Z. Kabir, F. N. Martin, and S. T. Koike. "Management of Soilborne Diseases in Strawberry Using Vegetable Rotations." Plant Disease 91, no. 8 (2007): 964–972. DOI: 10.1094/PDIS-91-8-0964.**

https://pubmed.ncbi.nlm.nih.gov/30780429/

Description: This peer-reviewed California field study compared vegetable rotations with standard fumigation in strawberry production. Broccoli and Brussels-sprout rotations reduced populations of Verticillium dahliae and reduced Verticillium-wilt severity, demonstrating that changes to the cropping system itself can directly suppress important soilborne disease.

34. **University of California Statewide Integrated Pest Management Program. "Non-Fumigant Alternatives for Soil Disinfestation: Strawberry Pest Management Guidelines."**

    https://ipm.ucanr.edu/agriculture/strawberry/non-fumigant-alternatives-for-soil-disinfestation/

    Description: UC IPM describes integrated nonfumigant strawberry strategies including resistant cultivars, sanitation, solarization, steam treatment, anaerobic soil disinfestation, soilless media, and other approaches. It reports commercial-scale use of rice-bran-based ASD in California, predominantly in organic production, and describes conditions under which strawberry yields can be similar to those from fumigated soil.

35. **Muramoto, Joji, Carol Shennan, Graeme Baird, Margherita Zavatta, Steven T. Koike, Mark P. Bolda, Oleg Daugovish, Surendra K. Dara, Karen Klonsky, and Mark Mazzola. "Optimizing Anaerobic Soil Disinfestation for California Strawberries." Acta Horticulturae 1044 (2014): 215–220. DOI: 10.17660/ActaHortic.2014.1044.25.**

    https://doi.org/10.17660/ActaHortic.2014.1044.25

    Description: This peer-reviewed California study reports that anaerobic soil disinfestation using rice bran was consistently effective at suppressing Verticillium dahliae and produced strawberry yields comparable with fumigant controls under appropriate coastal California conditions. It provides independent support for ASD as a practical nonfumigant approach.

36. **Fennimore, Steven A., Frank N. Martin, Thomas C. Miller, Janet C. Broome, Nathan Dorn, and Ian Greene. "Evaluation of a Mobile Steam Applicator for Soil Disinfestation in California Strawberry." HortScience 49, no. 12 (2014): 1542–1549. DOI: 10.21273/HORTSCI.49.12.1542.**

    https://doi.org/10.21273/HORTSCI.49.12.1542

    Description: This peer-reviewed California study tested steam soil disinfestation in research and commercial strawberry fields. Steam significantly suppressed weeds and soilborne pathogens at levels comparable to commercial chloropicrin/1,3-D treatment and supported favorable strawberry production, directly bolstering the argument that physical nonfumigant approaches can substitute for fumigation in some production systems.

37. **Shennan, Carol, et al. "Anaerobic Soil Disinfestation Is an Alternative to Soil Fumigation for Control of Some Soilborne Pathogens in Strawberry Production." Plant Pathology 67 (2018): 51–66. DOI: 10.1111/ppa.12721.**

    https://doi.org/10.1111/ppa.12721

Description: This peer-reviewed California research evaluated anaerobic soil disinfestation in strawberry production using controlled-environment experiments and field trials. ASD controlled several important soilborne pathogens, and in three of four field trials produced marketable fruit yields equivalent to fumigation. The authors concluded that ASD can be a viable alternative for control of some soilborne pathogens while emphasizing that efficacy depends on pathogen, temperature, and treatment conditions.