POSTHARVEST FUMIGATION RESEARCH AT USDA-ARS

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Abstract. Agricultural industries are facing, with increasing frequency, environmental and pest-related food safety requirements that are fundamentally difficult to balance. Failure to disinfest foodstuffs in trade and marketing channels can result in insect- and microbial-derived damage which limits economic profitability, curtails market access, and, more importantly, vectors plant and animal illnesses. This report describes critical research elements of the Crop Protection and Quality Research Unit of the USDA-ARS-SJVASC that specifically address this contemporary dilemma, one that will only become more challenging and important as world-wide demand on production and distribution expands over the next decades.

Case-studies.

QPS methyl bromide. Methyl bromide (MB) chamber fumigations were evaluated for postharvest control of spotted wing drosophila (SWD), *Drosophila suzukii*, in strawberry exports from California USA. Strawberries were infested with the most MB-tolerant age of SWD (60 to 108-h old at fumigation, ca. mature larvae), infested fruit were buried amongst uninfested fruit in export packaging, and fumigations were with 48 mgL^{-1} (3.0 lbs/1000 ft^3) for 3 hr at 18.0 ± 0.5 °C ($\bar{x} \pm s$). Complete mortality of 105,173 ± 3,321 ($n \pm s$) SWD specimens was achieved with applied doses ≥ 34.5 mgL^{-1} and exposures, expressed as a concentration x time products (CTs), ≥ 80.3 $mgL^{-1}h$.

Alternatives to methyl bromide. Research was conducted to ultimately reduce the need for the stand-alone postharvest methyl bromide fumigation of commodities that serve as a poor host for highly polyphagous insect pests. Novel methodology is presented for indexing the relative potential of hosts to serve insects. Results from studies examining host selection, utilization, and insect development were combined and quantitatively related via a Host Potential Index (HPI). Several aspects of the HPI are addressed including: 1) model derivation; 2) influence of experimental designs (no choice, two-choice, and multiple-choice); 3) model testing; 4) variable selection and weighting; and, 5) potential applications. The HPI was applied to the spotted wing drosophila (SWD), *Drosophila suzukii* Matsumura (Diptera: Drosophilidae), and seven "reported" hosts (blackberries, blueberries, cherries, grapes, peaches, raspberries, and strawberries) in a postharvest scenario. Four aspects of SWD-host interaction were examined: attraction to host volatiles; population-level oviposition performance; individual-level oviposition performance; and several key developmental factors. Results indicated that raspberries ($HPI_{1,7}$ = 350.5) have the greatest potential to serve as a postharvest host for SWD relative to the other fruit hosts, with grapes ($HPI_{7,7}$ =

248.8) having the least potential. The HPI provides a practical framework to synthesize the various elements of host-insect interaction into an overall expression of host potential.

Postharvest treatment methods. The chronological development of internally feeding insects on fresh fruit is rarely homogenous and depends, to a large extent, on the quality of the host fruit. Poorer quality fruit hosts tend to exaggerate developmental differences within a cohort with the effect being a dispersion of the developmental stage(s) vs. chronological age(s). Developing postharvest control treatments against insect pests typically requires the most treatment-tolerant life stage to be identified and used as the target to establish protocols. Targeting and treating a specific life stage for externally feeding pests is relatively uncomplicated since they can be readily identified and isolated. For internally developing pests, however, diagnosing the life stage present during treatment has been difficult and often assumed. Here, a method to calculate the probability distribution of life stages present at any given point in time from post hoc adult emergence is presented and applied to spotted wing drosophila (SWD), *Drosophila suzukii* (Diptera: Drosophilidae), developing on several types of fresh fruit. Our results clearly indicated differences in SWD development between fruits. Knowledge of the probability distribution at the time of treatment will likely lead to changes in experimentation and procedures required to develop treatments, whereby identifying the most tolerant "life stage" would be modified to the most tolerant "time span," followed by the probability of each life stage occurring within that time span being listed respectively. In postharvest scenarios involved with export treatments, the standard for efficacy depends upon pest mortality often measured by adult emergence for internally feeding pests. Our model can be used to calculate the probability that a surviving adult was at a particular life stage at the time of treatment.

References.

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Walse, S.S; Bellamy, D.E.. The Development of a Host Potential Index for Insects and its Postharvest Application to the Spotted Wing Drosophila, *Drosophila suzukii* (Diptera: Drosophilidae) *J. Econ. Entomol.* in press