United States
Department of
Agriculture

Light Brown Apple Moth Federal Quarantine Order Exemption

Commercially Produced Strawberries

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Executive Summary

The California Strawberry Commission (CSC) requested that the United States Department of Agriculture (USDA) amend Federal Order DA-2011-41, removing picked-and-packed fresh strawberry fruit from the Regulated Article List under the Light Brown Apple Moth (LBAM) Quarantine. The Commission also requested that an Integrated Pest Management (IPM)/systems approach be developed as a condition for removing organically produced strawberries from the Regulated Article List.

Based on evidence provided by the Commission and our current understanding of LBAM, we have determined that it is appropriate to remove picked-and-packed fresh strawberry fruit from the Regulated Article Listing and present an analysis of the evidence below. We agree that an IPM/systems approach should also be established for organic strawberries, but that organic strawberries should remain subject to the current restrictions and controls until such systems are in place.

Introduction

In a letter dated July 26, 2012 to Andrea Simao, National Program Manager of the USDA's Light Brown Apple Moth Program, the California Strawberry Commission (CSC) made two requests:

> 1. For USDA to amend Federal Order DA-2011-41, removing picked-and-packed fresh strawberry fruit produced using conventional (non-organic) field-production methodologies from the Regulated Article List. The Regulated Article List defines the specific commodities that may not be moved interstate from an LBAM-quarantined area.
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> 2. For USDA, the Cooperative LBAM Program, industry, and university extension to jointly establish a combination IPM/systems approach for picked-and-packed fresh strawberry fruit produced using *organic* field production methodologies that would meet the risk assessment criteria defined in Federal Order DA-2011-41. To be considered effective, this combination IPM/systems approach would need to prevent movement of LBAM life forms from the growing fields to the coolers or by transport to final destinations outside of the LBAM quarantine area in intrastate and interstate commerce.

In support of these requests, the CSC presented evidence that shipping strawberries out of the quarantine area is unlikely to introduce LBAM into new areas. The Commission specified that its request was only to remove conventionally produced strawberries from the Regulated Article List. Technical points raised by the Commission are presented below and are followed by our analysis.

Evidence provided by the California Strawberry Commission to support removal of conventionally produced strawberries from the Regulated Article List.

> "The demonstrated low incidence of cooler finds compared to field finds in both organic and nonorganic fruit production suggests that LBAM life forms on picked strawberry fruit are likely incidental rather than primary infestations of host material.

"While strawberry plants are a demonstrated LBAM host, the LBAM risk assessment presented no scientific citations or other literature to demonstrate that picked strawberry fruit were an LBAM host, or that LBAM life forms could even survive their life cycle and reproduce solely on the fruit of strawberry plants.

"The production practices of inspection during picking and culling from shipments of all cosmetically imperfect berries greatly reduces the potential for inclusion of LBAM life forms in picked and packed fruit and minimizes the incidence rate of LBAM in picked-and-packed strawberries. Further, it increases the likelihood that any foreign matter, including leaf litter and pests (such as LBAM life forms), is detected and eliminated at the time strawberries are packed into trays for transport to the coolers.

"Best management practices, 1PM, and grower and pest control advisor programs for in-field scouting, trapping, degree-day-modeling, and other monitoring activities trigger treatments with LBAM-labeled pesticides that are highly effective at preventing LBAM from surviving and traveling from the field on commodity picked fruit, even from fields located in areas endemically infested with all LBAM life forms.

"Market pipeline and end-use of picked fresh berries in plastic clamshell packaging restricts commodity strawberries to refrigerated transport, and display within days of picking, an environment unsuitable for LBAM development and reproduction.

"Home refrigerated storage and end-use cleaning, cooking, or fresh consumption by the consumer over short timeframes renders all commodity strawberries inhospitable to LBAM life form survival and/or release to the wild.

"The USDA/APHIS LBAM Risk Assessment named commodity strawbe1T)' fruit and plants as a high potential avenue for transport of LBAM life stages based primarily on literature research from Australia and New Zealand. Production practices differ greatly in the United States, including highly sophisticated 1PM and systems approaches not in use at those times in those locales. The efficacy of these processes in preventing movement of LBAM life forms in California agricultural production has been statistically validated through the LBAM Progran1 inspection record."

APHIS Analysis of the CSC Evidence

For LBAM to be introduced from the quarantine area into a new area, a number of individuals must arrive in the new environment, survive to adulthood, find one another and mate, and locate suitable hosts on which to oviposit. Any factors that make those events less likely will lessen overall risk.

The Commission stated that commercial strawberries have not been shown to be an LBAM host. It appears that the Commission is suggesting a "conditional host" status, because they concede that wild or non-commercial strawberries can be a host. The term "conditional host" has been defined as "a host plant unequivocally not found infested in the field but that can be infested under manipulated conditions (also called potential or artificial host)" (Aluja and Mangan, 2008).

However, the term "host status" would be incorrectly applied by the Commission in this case. Conditions in commercially produced strawberries may make it difficult for LBAM to survive, but that outcome is not the same as non-host status. Additionally, there is evidence that LBAM can survive in commercially produced strawberries. For example, light brown apple moth was intercepted 34 times on *Fragaria* sp. in permit cargo from New Zealand between 1985 and 2012 (PestID, 2012). This observation equates to an average of 1.25 larvae per year on an average quantity of imported strawberries valued at $3 million of per year. The number is not high, but it does demonstrate that LBAM feeds on commercial strawberry. The Commission also points out that production practices in Australia and New Zealand are different from California production practices in several key ways, and these differences will make LBAM infestation much more likely in those countries. That distinction is likely true, but the effect of production practices should not be confused with host status.

The Commission maintains that 1PM prevents LBAM from surviving in the field to be picked at harvest. IPM includes actions such as scouting, trapping, degree-day modeling, and chemical intervention when certain thresholds or "triggers" indicate that treatment is necessary. A more detailed account of IPM is given later in this document. Based on the very low number of LBAM larvae that have been found by inspectors under the quarantine program, the current IPM strategy appears to work very well. Light brown apple moth is principally a leaf roller that damages fruit when population numbers are high (Danthanarayana, 1975). Since larvae appear to feed on fruit mostly by chance in proportion to the total surface area available (Lo et al., 2000), only a small portion of all the larvae in a field or orchard are expected to be associated with the fruit at harvest. Low population numbers make fruit association even less likely.

The Commission also presented evidence that harvest practices reduce risk. Fruit are inspected during picking and damaged fruit are not harvested or are culled from shipments. This practice also insures that no leaf material moves with the berries, with the exception of the green calyx (or cap) of the strawberry, which presumable remains. Light brown apple moth is normally considered a leafroller that damages fruit only when leaves are webbed to the fruit (Danthanarayana, 1975). Removing leaf material and discarding cosmetically imperfect berries should indeed reduce the risk that larvae will be transported with strawberries. This outcome is equally true of conventionally and organically produced strawberries.

In further support of the effectiveness of IPM practices, the Commission reported that LBAM larvae were found in very few of the field inspections carried out under the quarantine order. We also examined the original inspection data and determined that the number of finds was very small. However, our data did not fully correspond with those quoted by the Commission, possibly because we looked at different versions of the data sets, that time scales were different, or that the data sets were queried differently. The Commission made one statement that was especially difficult to interpret, as follows:

> "In total, 493 positive LBAM insects were identified as resulting from finds in strawberry grower fields or coolers. Of the 81 positive finds, 63 finds resulted in 493 LBAM from grower field inspections; 18 finds produced 38 LBAM from strawberry cooler inspections."

The first sentence reports 493 positive insects identified in total from fields and coolers, but the second sentence notes that there were 493 finds from grower field inspections and an additional 38 from cooler inspections. This reported total may have been a misprint.

In the data we examined from 2007-2011, growers were subjected to a total of 7,585 routine inspections. Of those inspections, LBAM larvae were found 52 times; seven times in non-organic operations and 45 times in organic operations. Processor coolers were inspected only 10 times, although they were scouted 68 additional times. No larvae were found. Based on the evidence provided to us, it is rare for LBAM to be found in fields where strawberries are produced, and larvae have not been found in strawberries harvested from the quarantine area of California (although very few samples were taken). As of this writing, no LBAM infestations outside of the LBAM quarantine area have been traced back to suspect sources identified as resulting from strawberry fruit movement.

The Commission pointed out that strawberries are packed in clamshell containers and refrigerated during transport to market. They also stated that consumers typically refrigerate strawberries and consume them rapidly, either by cooking or eating fresh, making it impossible for LBAM life stages to reach hosts in the wild. Refrigeration would indeed stop larval development. The lower threshold for development for all stages of LBAM is 7.5°C.; no development occurs below this temperature and prolonged exposure to lower temperatures leads to loss of vigor for most individuals within a population (Danthanarayana, 1975). Refrigeration temperatures are typically around I °C, well below the developmental threshold. We could find no evidence that LBAM larvae can complete development on strawberry fruit without leaves.

Difference in risk between non-organically produced and organically produced strawberries

In support of its petition, the Commission identifies the following customary production practices used by commodity strawberry growers in California to reduce LBA1v1 infestation and population levels. Text from the Commission follows:

> "Organic grower requirements impose a lapse of three (3) years from the application of any soil fumigant to fields used to grow strawberries for organic production despite solid scientific evidence that such fumigants are quickly dispersed to undetectable levels in the soil following application and before planting takes place.
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> "Common organic grower economic preference exists for retaining strawberry production plants for a second or third season, a practice that Cooperative LBAM Program and university extension staff believe allows LBAM populations to become established in organic production fields and increase to population levels that are statistically demonstrated to be much higher than in the case for replant each season in conventional production fields.
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> "Lack of adequate and effective, organic-approved treatment options exist to control and eliminate LBAM populations upon detection of infestation in organic production fields without voiding their organic designation.
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> "No post-harvest treatment options are available to effectively eliminate LBAM life forms from picked strawberry fruit within the time frames and economic constraints imposed by fresh berry market requirements."

Analysis of organic vs. **non-organic risk**

Geier and Briese (1981) stated that, all other things being equal, the most important factor determining the infestation level of the crop in a particular season is the number of larvae that survive the winter. Overwintering LBAM larvae are commonly found in the ground cover of deciduous orchards, including fallen leaves (Geier and Briese, 1980). Removing all plants and ground cover, as well as plowing the field under, as is commonly practiced in conventional strawberry production, likely considerably reduces the overwintering LBAM population. In organic production the plm1ts are typically retained for two or three years. In California, temperatures are mild and strawberry plants are capable of growing all year long (UC ANR, 2013), providing LBAM with a continuous host. Even in cases where leaves are lost in winter, larvae have been shown to survive on the ground within dead apple leaves equally as well as larvae in weedy ground cover (Geier and Briese, 1980).

The evidence provided by the Commission stated that organic producers impose a three-year period between soil fumigation and planting, thus losing the presumed beneficial effect of fumigation on reducing LBAM populations. The Commission did not state that conventional growers fumigate every year, but this seems to be implied, and also appears to be common practice in California (Larson and Shaw, 1995). The fumigation is directed primarily against nematodes and pathogens (Larson and Shaw, 1995), but likely has an adverse effect on overwintering larvae.

Geier and Briese (1981) maintained that certain production practices like fertilizing and irrigating, and treating with broad spectrum insecticides tend to promote LBAM infestation. Vigorous plants favor LBAM population growth and pesticides can reduce or eliminate natural enemies. LBAM, by contrast, has a low susceptibility to conventional treatments. To the extent that conventional strawberry production uses broad spectrum insecticides, organic production may actually favor natural enemies, which have been shown to be effective at reducing LBAM populations (Lloyd et al., 1970). The Geier and Briese (1981) paper was written before many of the more targeted insecticides such as insect growth regulators, spinosads, and others were developed, however, and current IPM practices used by both organic and conventional growers attempt to preserve natural enemies.

The number of inspections that revealed LBAM larvae in strawberries is small for both orgm1ic and conventional production. According to our estimates, routine inspections found LBAM around 4 percent of the time at organic sites (45 out of 1153) and around one tenth of 1 percent (7 out of 6005) at conventional sites. In the sites where LBAM larvae were detected, more larvae were present in organic sites than conventional sites. Clearly, conventional production reduces LBAM populations more effectively than organic production. It is yet to be determined whether the population levels remaining after organic production constitute a risk for introducing LBAM outside of the quarantine area through the movement of strawberries.

Conclusion

Based on evidence provided by the Commission and our current understanding of LBAM biology, we have determined that it is appropriate to remove picked-and-packed fresh strawberry fruit produced using conventional (non-organic) field-production methodologies from the Regulated Article List. We agree that an IPM/systems approach should also be established for

organic strawberries, but that organic strawberries should remain subject to the current restrictions and controls until such systems are in place.

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