

Systems Approach for Managing Risk Associated with Movement of Fresh Tomatoes during a Medfly Outbreak

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Executive summary

Fruit flies of the family Tephritidae are important pests for fruits and vegetables worldwide and their presence in areas where the pest is not established represents a significant threat to commercial agriculture and trade. Local, regional and national governments utilize a number of regulatory measures to reduce risks associated with movement of the host commodities from fruit fly infested areas ranging from outright prohibition to requiring quarantine treatments. Various quarantine treatments using fumigants, heat, cold and irradiation have been shown to be effective. More recently, regulatory officials have embraced the use of “systems approaches” as an alternative means to allow movement of commodities in lieu of using a single or combination treatment while effectively mitigating the risk posed by fruit flies to acceptable levels.

This study proposes using a “systems approach” to allow interstate movement of tomatoes whenever a Medfly outbreak occurs based on the following measures: 1.) area freedom prior to a detection based upon standard surveillance trapping and area of low pest prevalence demonstrated by delimitation at higher trapping densities whenever a Medfly is detected, and 2.) unsuitable or poor host status of tomatoes to Medfly infestation.

This study provides a “framework” for development of a systems approach for the movement of commercially-grown tomatoes from areas quarantined for the Mediterranean fruit fly [Medfly], *Ceratitis capitata*, occurring in Florida or California. The study shows that tomatoes are not a suitable host of Medfly. The development of a systems approach will allow growers and processors to safely move tomatoes outside of areas regulated by Federal quarantine while ensuring an acceptable level of risk.

Most areas of the continental United States are free from harmful subtropical fruit flies. In those areas vulnerable to fruit fly introduction and establishment, Federal and State officials maintain and service an array of traps aimed at early detection and rapid response to incursions of tephritid fruit flies. Detection trapping gives evidence that these areas are and remain fruit fly free. This surveillance grid enables plant protection officials to take prompt actions based on predetermined "triggers" that allow for an incremental response starting with delimitation of an outbreak and, if necessary, eradication and regulatory measures. Emergency actions against fruit fly introductions that may include pre- and post-harvest treatments continue until eradication is achieved by maintaining delimitation trapping for three generations since the last fly find.

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1. INTRODUCTION

1.1Fruit fly risks

Fruit flies of the family Tephritidae are important pests for fruits and vegetables worldwide and their presence in areas where the pest is not established represents a significant threat to commercial agriculture and trade. Fruit flies represent a particular risk because 1) eggs are laid inside the fruit, so immature fruit flies often develop undetected, at least during the early stages of an invasion, and 2) fruit flies lay multiple eggs inside fruit, resulting in a riskier, “clumped” distribution within a consignment or smuggled fruit.

Where the potential risk of fruit fly introduction and spread exists, local, regional and national governments utilize a number of methods to reduce the risk associated with host movement ranging from outright prohibition of the commodity from potentially infested areas to approval based on quarantine treatments designed to eliminate the risk. Single quarantine treatments have been shown to be effective. More recently, regulatory officials have embraced the use of “systems approaches” as an alternative means to allow movement of commodities in lieu of using a single or combination treatment while effectively mitigating the risk posed by fruit flies to acceptable levels (ISPM 14 2002) because quarantine treatments may not exist, they may cause unacceptable damage or are not practical.

1.2 Systems approaches to manage risk

Movement of commodities where fruit flies are present has historically been subject to approval by the importing localities and/or (in some cases) bilateral agreements between importing and exporting entities. These agreements are normally based on commodity pest risk assessments on whether pests present in the commodity could enter and become established in incoming commodity shipments. Sometimes these assessments have resulted in functional “trade barriers” that are not always based on scientific “risk assessments” such as the likelihood that a mating pair of insects could survive any treatment and become established (Landolt et al 1984). Mitigation of risk associated with new pest introduction has historically employed single quarantine treatments such as fumigation, heat, cold treatments, irradiation, etc. that are meant to alleviate/reduce risk to a low (near zero) level (Sharp and Hallman, 1994, Paull and Armstrong, 1994). The standard measure of efficacy has been 99.9968% (probit 9) (Baker, 1939) especially for fruit flies. While this standard measurement of efficacy has largely been effective in risk mitigation, it is based on the premise that significantly large population pressures of the pest exist where the crop is grown. In practice however the high populations that might be associated with the "generally infested" condition is rare in commercial production areas due to pest management procedures put into practice by growers. Additionally, some commodities can be damaged by single quarantine treatments (e.g. heat, cold, fumigation, irradiation) resulting in quality and shelf life problems. Intra- and Interstate quarantines such as those which might occur as a result of a new detection of fruit flies or other pest could limit even movement outside of the quarantine areas unless suitable risk mitigation measures are undertaken and approved.

Over the last 20 years scientifically-based concepts have been internationally adopted to provide a more biologically-based framework to assess and mitigate risk. These concepts include " probability of a mating pair" (Landolt et al, 1984), "maximum pest limits" (Baker et al. 1990), "pest free areas and areas of low prevalence" (Riherd et al. 1994; NAPPO Regional Standards, 1994, 2002 & 2003; ISPM, 2005 2007, 2008), "host status and resistance" (Greany, 1989, 1994; Liquido et al, 1995; NAPPO, 2008) and "systems approaches" (Jang and Moffitt,1994; IPPC, 2002). Recent reviews (Follett and Neven, 2006; Aluja and Mangan 2008) discuss in more detail these and other concepts related to quarantine entomology and fruit fly biology. Recently, regional standards such as the North American Plant Protection Organization,(NAPPO, various dates) and international standards from the FAO's International Plant Protection Convention, (IPPC, various dates) have been developed with the overall goal of harmonizing methods for dealing with risk associated with the threat of establishment of invasive species. The concept of the "systems approach" (Moffitt, 1990, Vail et al. 1993; Jang and Moffitt 1994, Jang, 1996, Jang et. al. 2006) was developed largely to support biologically-based risk-assessments and mitigations that could occur in a broader based "system" of activities that cumulatively meet quarantine requirements of the importing country when they are backed up by strong scientific data (or in some cases expert opinion). While not new, systems approaches are now internationally recognized by member parties of the World Trade Organization (WTO), and the IPPC providing a framework for harmonizing risk assessment and mitigation, and a forum for oversight when disagreements exist (ISPM 14 2002).

2. SELECTION OF THE SYSTEMS APPROACH FOR TOMATOES

U.S. Federal and State authorities declare emergency quarantines when new detections of Medfly, are found at levels exceeding a predetermined “trigger”. This trigger is exceeded when a fertile female is found, two or more adult flies are caught or when immature stages (eggs, larvae or pupae) are found in fruit from commercial or residential surveys. The quarantine area encompasses 81 sq. miles around the find site. The size of the area is adjusted if fruit flies are found at multiple sites. Robust eradication actions are conducted within the core 1 sq. mile around each find that includes application of sterile insects (SIT), foliar bait sprays, fruit stripping, and quarantine controls to further reduce the probability that the infestation will spread outside the quarantine area. This declaration of a quarantine changes the designation of an area from “fruit fly free” to one that is considered “generally” infested. In reality, the new designation as a generally infested area may be too severe given the success of eradication programs.

Under new IPPC guidelines for fruit flies, with appropriate trapping and verification, such areas could be functionally considered “area of low pest prevalence [ALPP]”. Thus ALPP along with other independent measures such as poor host status could be considered as major components that would make up a systems approach to allowing the interstate movement of tomatoes from areas quarantined for Medfly. The USDA uses ALPP currently as one of the independent measures in systems approaches concerned with the importation of fruit fly host material. This includes the importation of papaya and tomato from Medfly-infested countries. The specified level of low pest prevalence used for the same pest can differ for each systems approach which in part is determined by the effectiveness of the other independent measures (IPPC 2008; FAO/IAEA 2011).

Poor host status of tomatoes was assessed as a potential second major (independent measure) component based on an exhaustive review of published findings showing an absence of infestation that includes interception data, results of fruit cutting during outbreaks, and laboratory and field infestation tests. These findings provide a body of evidence that shows tomatoes are a poor host for Medfly. In this document, major component and independent measures are synonyms (FAO/IAEA 2011).

This document discusses and recommends a systems approach for tomato (*Solanum lycopersicum* L.) which includes cherry tomato (*Solanum lycopersicum* L. var *cerasiforme* (Alef)). Tomatoes commonly are reported in publications under the synonyms of *Lycopersicum esculentum* Mill. and *Lysopersicum lycopersicum* (L.) H. Karst. (GRIN 2014)

3. INDEPENDENT MEASURES [MAJOR COMPONENTS]

In this section evidence is presented concerning the prevalence of Medfly during an outbreak under robust emergency response measures and the poor host status of tomatoes for Medfly. These factors are major components in a potential systems approach for movement of tomatoes from a Medfly quarantine area.

3.1 AREA OF LOW PEST PREVALENCE

3.1.1 General quarantine situation

USDA, California and Florida Departments of Agriculture employ a “grid’ of traps baited with trimedlure and food-based (multilure/3 component) attractants in urban and agricultural areas targeting early detection of Medfly. Medfly has been detected on a recurring basis in California and less often in Florida resulting in implementation of emergency detection and/or eradication procedures depending on whether or not trapping triggers are exceeded. To mitigate the repeated occurrence of Medfly detections USDA and states employ a preventative release program (PRP) of sterile flies in key areas of the state. Delimitation trapping within the grid is triggered by the capture of a single wild fly. Regulatory triggers for Medfly include the detection of a mated female, immature stages (eggs, larvae or pupae) or capture of two or more adults.

The normal trapping grid before detection is generally from 5 – 12 traps / sq. mile in urban areas depending on risk and 1 trap / 6 sq. miles in rural areas deemed to pose lower risk. After detection of one or more Medflies, trapping is increased greatly. Delimitation trapping in the core square mile is increased to 100 or more traps within 24 hours which are serviced daily until the first treatment is made while the surrounding 80 sq. mile quarantine area will have between 1600 to 2680 traps in service. Fewer traps are used when a preventative release program is carried out involving weekly distribution of sterile Medflies on a continual basis. For example, 50 TML traps, Champ traps or yellow panel traps together with 50 ML traps may be installed in the core sq. mile while the surrounding 8 sq. mile buffer contains 20 ML traps/sq. mi. The above totals are for all traps used for Medfly using either trimedlure or food-based attractants. The average density of traps used in the quarantine area ranges from 19 to 33 traps per sq. mile (CDFA 2010; FDAC 2011). These increased trapping arrays are meant to increase the likelihood of detecting additional fruit flies within the quarantine area. In addition, trapping results give information on prevalence of flies in the trapped area, effectiveness of treatments and can be used to verify an ALPP based on IPPC guidelines. Given that the normal grid of either one or five traps\sq. mile is not increased outside of the quarantine area suggests intuitively that areas under quarantine are more “secure” further justifying the designation of ALPP (as long a no additional flies are caught) using the criteria set forth in ISPM 30 - Establishment of areas of low pest prevalence for fruit flies (Tephritidae). For this reason, ALPP is considered as a major component \ independent measure of a systems approach for tomatoes.

3.1.2. Relative density of Medfly within the quarantine area

Empirical data from previous Medfly outbreaks in California and Florida strongly indicate the probability of additional Medflies being captured after an outbreak triggers are met are much greater in a per trap basis from traps located in the core areas (generally one sq. mile) than in the buffer areas. For Medfly, unless the trap density is very great (i.e. 1,000 traps /sq. mile) the traps should not compete with each other. Thus the relative density of Medfly in the core area compared to the various buffer areas can be estimated.

In a 1995 assessment, Miller and Chang (1995) determined that the probability of capturing an additional fruit fly in a trap was 20 times greater in the core than the first buffer and 100 times greater than in the outer buffers. By estimating the relative density of Medfly in the core compared to the buffer areas we can assume that the risk to fruit fly hosts including tomatoes in the core areas are 20 -100 times more at risk than in the buffer areas. This was estimated from six selected Medfly outbreaks occurring in California and Florida between 1987 and 1993.

To confirm the large difference in risk between the core and buffer areas we assessed the fly captures on more recent Medfly outbreaks. We selected 10 Medfly outbreaks occurring in between 1994 and 2009. The data show that the probability of capturing an additional fruit fly in a trap was 33 times greater in the core than the first buffer and 1000 times greater than the outer buffers.

Outbreaks between 1987 and 2010 were not selected if:

- No additional Medflies were captured during the outbreak
- The quarantine area contained more than one core area

- Two or more outbreaks occurred in a relative small area
- 1000 traps/sq. mi or more were used in the core

More details of the relative density of Medfly between the core area compared to the various buffer areas are given in Appendix A. Given the above the risk of tomatoes, one could assume that ripe tomatoes from the buffer poses much lower risk than from the core area.

This information provides evidence that production areas are fly-free. When an outbreak is triggered, these areas can be considered as ALPP from a regulatory perspective based on delimitation trapping at higher densities.

3.1.3 Integrated pest management in commercial tomato production in support of ALPP

In 2009, farm value of commercial tomato production (fresh and processing) in California and Florida totaled $2 billion (USDA ERS). Together these two states produce the majority of tomatoes grown in the US (USDA NASS). Pre- and post-harvest management are carefully managed through small and large corporations with the help of farm advisors and extension agents. Management of pests normally follow integrated pest management programs that establish the presence of pests, selection and timing of control measures such as pesticide applications and harvest protocols based on state and federal regulatory guidelines. During times when invasive fruit flies are not present, pesticides used for their control are not applied. However the presence of other tomato pests , such as whiteflies, thrips, etc., requires pesticide –based management strategies applied to the tomato cropping systems in most cases (organic growers may have different IPM strategies). Many of the pesticides approved for use on other pests also have activity against fruit flies to some extent and would reduce fruit fly populations when applied and contribute to ALPP. Although specific efficacy data on formulations approved for pests such a leaf miners and surface pests may not be available for fruit flies, the fact that the active ingredients (e.g. malathion, lamda-cyhalothrin, spinosad) may be similar to known formulations that are approved for fruit flies would suggest that application of such chemicals (routinely used as a cover spray) would have some activity if flies would be present. The fruit fly bait spray has both attraction, feeding, and contact toxicity whereas cover sprays act mostly as a contact insecticide. Nonetheless the presence of these chemicals on the crops are likely to have some effect on any fruit flies that might be present in the fields. This would serve as an additional mitigation in maintaining an ALPP. A list of the pesticides approved for insect control on tomatoes in FL are included in Appendix B as an example of the chemicals that may also control fruit flies.

3.2. POOR HOST STATUS

The evidence collected and assessed concerning the host status of tomatoes for Medfly in this report include published literature, interception data, fruit cutting results during US mainland outbreaks of Medfly and forced laboratory infestation results. For the purposes of this report we refer to the term poor host as synonymous with the term conditional host as outlined in the NAPPO RSPM 30 guideline (2008). This evidence or a summary of it is given below and in some cases more details are presented in appendices.

3.2.1. Host Status of Tomatoes Based on Published Literature and Reports

A large number of scientific articles have been published concerning host plants of Medfly, the most notable by Liquido *et al.* (1998), called MEDHOST, consists of an encyclopedic bibliography of the host plants of Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (electronic database program). In 2013 MEDHOST was revised, version 1.1(Liquido, *et al., 2013).* MEDHOST uses 109 documents (published and unpublished from 1902 to 1992). For each of the 374 host plant entries, it gives various data including common and botanical name. It also summarizes field and/or laboratory infestation data, and when it lacks evidence of infestation it states that the hosts are "listed only". MEDHOST provides 27 entries for tomato, 5 contain data concerning field infestations (one had negative findings only) and most of the others were "listed only". The laboratory infestation data is addressed below in Appendix E. Every effort was made to obtain and review any evidence concerning the field infestation data from this database.

In addition to above, a general review was conducted using online databases, the US National Agriculture Library, APHIS libraries and other sources. Discussed in detail in Appendix C is useful information obtained from MEDHOST, the results from the general literature review, and subsequent inquiries for more details or other questions concerning their publication.

Publications given field infestation data from outside the United States are rare. The best examples found were 1) one larva found in a backyard tomato during a 1924 Medfly survey in Spain, and 2) two larvae found in a single ripe tomato originating from a market garden from Western Australia in 1955 (Jenkins, 1955). Other examples could not be confirmed.

The other good records of field infestations are from Hawaii. Liquido et al. (1990) found five collections infested with Medfly out of 266 collections of tomato between 1949 and 1985. Liquido et al. (1994) found one larva each from two collections of cherry tomatoes out of a total of 117 large collections of tomatoes. The collections in the above two papers were from tomatoes grown in backyards or small mixed produce truck farms. Some of the fruits were from the ground and some ripe. The numbers of infested lots found in Hawaii reflects the large amount of field studies concerning fruit flies occurring over the years.

Some of the other documents reviewed were or contain annotated host lists which gave some insight. Comments and host classification for tomatoes included “overripe only” and “occasionally infested” (see Appendix C). From the above it can be concluded that at least ripe tomatoes can be infested in the field by Medfly and that this appears rare.

Scientific evidence to support poor host status of tomatoes are also reflected in a peer-reviewed published report by Chan and Tam (1985) reporting on the association between host survival and alpha-tomatine levels in tomatoes.

3.2.2. Pest Interception Data from US Ports of Entry for Tomatoes

APHIS recorded 3,334 interceptions of *Ceratitis capitata* between 1984 and Jan 2012. These interceptions originated from various foreign countries and Hawaii. There were no recorded interceptions of Medflies in tomatoes. The vast majority of these Medfly interceptions were in fruit carried for consumption by the travelling public. A small number were from shipments of cargo, ship stores, and other pathways.

During the same time period, APHIS recorded 5,062 interceptions of other reportable/quarantine pests for tomatoes. None of these interceptions were Medfly. Of these other pests found, 204 were found ‘in’, 4,299 ‘on’ and 559 ‘with’ tomatoes. [The above interception data was provided Jan. 30, 2012 by Pete Touhey, National Identification Services, USDA, APHIS, PPQ, and Riverdale, MD.]

We also could find no other mention of interceptions of Medfly in tomatoes from various other APHIS documents including pest risk assessments or 'Decision Sheets' (Decision on Entry Status of Fruits and Vegetables Under Quarantine No.56).

3.2.3. Fruit Cutting Results during Medfly Outbreaks in the continental United States

Tomatoes have never been found infested during a Medfly outbreak. Larval infestation data was reported for all Medfly outbreaks occurring in the US mainland where Medfly infested fruit was found. The number of properties containing hosts of Medfly where larvae were found (e.g. "larval properties") were reported for one outbreak in Texas (15 properties), for all outbreaks in California (539 properties), and for the outbreaks in Florida since 1997 (34 properties). This is a total of 588 recorded "larval properties". In the earlier outbreaks occurring in Florida only the hosts found infested were reported, not the number of times hosts were found infested. At least 32 host taxa were reported infested with Medfly. Apricot, sweet orange and peach were the most commonly reported hosts found infested with Medfly. At least during the more recent outbreaks, fruit cutting of reported hosts around the trap captures of Medfly was the norm. Details of infested fruit found during these outbreaks are in Appendix D. A question can be asked, 'how often are tomatoes cut during outbreaks?' We were able to only obtain four reports of fruit cutting that listed the type of fruit cut where no larva were found. These all were from California. A summary of these reports are included in Appendix D. In one outbreak, 2.6% (28.5 lb.) of the total fruit cut was tomatoes. In one outbreak, no tomatoes were cut. In another outbreak, tomatoes were cut but the amount not recorded. In the last outbreak, only one of the cut fruits, lemons, were reported by name.

3.2.4. Laboratory Infestation Results

Host status has become a primary consideration when developing metrics related to risk of a commodity becoming infested by pests such as fruit flies. Fruit flies represent a particular risk due to 1) the fact that eggs are laid and the immatures develop inside the fruit and are often undetected at early stages of infestation and 2) that multiple eggs can be laid in the fruit resulting in a “clumped” distribution within a consignment. Still the approaches used to establish host status have historically been developed through collections of fruit and through more controlled laboratory “forced” infestation or choice tests. Back and Pemberton (1918) reported infestation of tomato by Medfly and although their laboratory data suggested that tomato could be infested they also stated that it is a poor host of Medfly.

In 1994, forced infestation studies were carried out at Almería, Spain (anonymous 1994) in greenhouses using both large tomatoes (var. Daniela) and a single variety of cherry-type tomatoes. No infestation was observed in 24 hr. infestation periods. Ripeness categories in this test were not identified.

A report by Rossler (1988) to APHIS concerning infestation tests in Israel of several varieties of tomato states that varieties tested were not attacked by Medfly while on the vine and only poorly infested from 1-6 days after picking leading to the conclusion that tomato is not a host of Medfly under normal conditions and only a poor host under the most restricted conditions of forced infestation. Additionally examination of over 2000 culled fruit from the tomato packing shed did not turn up any infested fruits also supporting the evidence of poor host status.

Studies conducted in Morocco by the Moroccan Ministry of Agriculture on forced infestation of harvested Daniela variety of tomatoes (Green et al, 1996, unpublished trip reports) showed only low infestation despite high populations of flies in the cages (40 tomatoes and 800 flies). They also conducted forced infestation studies of tomatoes on the vine with over 2000 flies in the field cage and reported only 3 of 4531 tomatoes with larvae in the fruit. Bananas used as controls had many larvae in the fruit. Finally they tested both damaged and undamaged fruit for evidence of infestation under forced conditions. None of the undamaged fruits had larvae and none of the commercially harvested stages of tomatoes (stage 2 – 3) were infested even though some had obvious damage.

More recent tests conducted in Hawaii on beefsteak- type tomatoes in both forced no-choice tests and choice tests of 1-3 day old harvested tomatoes using lab-reared Medflies generally confirmed the results of others relative to the poor host status of tomatoes (see Appendix E). These studies utilized commercial greenhouse grown large tomatoes (off the vine). We studied infestation in six different ripeness categories (Standard US color charts) commonly used in commercial production of tomatoes in the US. In no-choice forced infestation trials, Medfly will lay eggs in tomatoes from green to fully ripe but preferred the riper fruits. Larval development, pupation and adult emergence varied with individual tomatoes and ripeness but we generally found that the risk of infestation increases with fruit ripeness with green tomatoes rarely attacked. In contrast ripe tomatoes (exposed to the same cohort of flies) had many more larvae and control tomatoes with no flies did not show any infestation from the field.

We also conducted trials with harvested tomatoes of three different ripeness exposed to gravid female Medflies in field cages to assess if infestation decreased as a result of choice behavioral assays that allowed flies to choose among different ripeness of tomatoes concurrently. The results of these trials showed that only one tomato (of twenty) in the commercially harvested (green) stage of ripeness was infested.

4. CONCLUSIONS

Emergency quarantines aimed at stopping interstate movement of fruit fly host material from infested areas to non-infested areas lends itself to the application of a systems approach to mitigate potential spread whenever a fruit fly outbreak occurs. Prior to the declaration of the quarantine, fruit flies are not present in the area and the area is considered fly free from a regulatory perspective. The immediate application of specific emergency response measures such as increased trapping, fruit stripping, application of chemical bait sprays and increased release of sterile insects make it likely that areas undergoing fruit fly eradication can be considered as areas of low pest prevalence (ALPP) as long as significant numbers of adults and other life stages are not found indicating the presence of an established breeding population. t is also likely that existing IPM measures aimed at control of other pests of tomato have at least some additional suppression effects on any Medfly that may venture into a commercial field further supporting ALPP. Thus ALPP could be considered as an effective independent measure based on the evidence presented above. Based on accepted IPPC guidelines, systems approaches utilize at least two independent measures (major components) integrated into a system of activities that cumulatively reduce the risk of invasive pests becoming established.

The results of the reviews of published literature, pest interceptions, fruit cutting, and forced infestation suggest that tomatoes are relatively poor hosts of Medfly. The majority of reports listing tomatoes as hosts come from only a few published reports. Reports of natural infestation of Medfly in tomatoes come from field collections of non-cultivated, dooryard, or small truck farms of mixed crops. Large commercial plantings have implemented pest management strategies (including pesticides) against other insect pests which are in many cases known to kill fruit flies; thus decreasing further the likelihood of live eggs or larvae in the fruit. Of the thousands of pest interceptions of Medfly none were listed as on tomatoes. Finally the forced infestation data from other reports as well as more currently investigations support the notion that tomatoes (especially green commercially harvested) is not a good host of Medfly.

Based on all of the above evidence the overall risk of Medfly coming from tomatoes under a recently discovered outbreak under emergency quarantine with active eradication procedures in place would be low. Thus poor host status could be considered as a second independent measure of a systems approach.

4.1. The Proposed Systems Approach

The proposed systems approach was developed by the authors with considerable input from State (FL and CA), USDA fruit fly experts and risk analysts. Additional input was received during site visits to FL and CA and during two separate meetings with experts and APHIS staff in Raleigh, NC.

Proposed Systems Approach for Interstate Movement of Fresh Tomatoes from Areas Regulated for Medfly During an Outbreak

The main components of this proposed systems approach are an area of low pest prevalence and poor host status. The evidence/elements to support this systems approach include:

4.1.1 Area of Low Pest Prevalence

- The pest is not permanently established in the continental US
- Imported host material is under strict quarantine from areas where Medfly occurs

- An effective detection program is conducted in states vulnerable to Medfly introduction and establishment.
- Delimitation trapping is carried out immediately upon detection of a single Medfly capture in accordance with emergence response measures as outlined in action plans/protocols.
- Immediate implementation of a control/eradication program including fruit stripping, ground treatments, aerial treatments (SIT or bait sprays) and regulatory control of host material moving from areas under quarantine.
- Pest control measures taken in commercial plantings for other tomato pests also serve to suppress and eradicate Medfly.

4.1.2 Poor Host Status

- All published literature indicates that tomato, *Solanum lycopersicum* L., is a poor host. No varieties were reported as fair or good hosts for Medfly.
- Records of field infestation are limited to ripe tomatoes collected from backyards or small truck farmers (in Hawaii this is usually < 2 acres).
- Out of 3,334 interceptions of Medfly at US ports of entry between 1984 and 2012, none have been found infesting tomatoes.
- Fresh tomatoes have never been found to be infested with Medflies during fruit sampling and cutting during outbreaks in the continental US from 1929 to present date. Medfly larvae were found infesting other hosts on 596 properties.
- During forced infestation studies conducted in the laboratory on various varieties of tomatoes, only ripe tomatoes became infested while non-ripe tomatoes were either a non-host or resistant to infestation.

4.1.3 System descriptions

Within the general systems approach for tomatoes, two alternatives are proposed. Combined, these alternatives would allow the majority of tomatoes grown within a Medfly quarantine area to be moved and sold under less restrictive measures than currently are required by regulation. Home grown tomatoes or tomatoes sold at or near the farm at a fruit stand are excluded from these provisions. Only commercially-produced and harvested tomatoes would qualify for interstate movement under this systems approach.

System Alternative One – This system applies to growers/packers who harvest and pack only green and breaker stages of tomatoes. This would apply to tomatoes grown within the quarantine area, but not within the chemical treatment zone. The chemical treatment zone is the area within the immediate vicinity (usually a 200 to 400 meter radius) around a fruit fly find site where fruit stripping and ground spray occurs.

1. Growers and packers need to sign a Compliance Agreement (CA) with the state department of agriculture.
2. Tomatoes can be moved to an approved packing house within or outside of the quarantine area under currently approved safeguards. The product can then be treated with ethylene to ripen, store, and/or ship before or after the fruit ripens.
3. If the packing house is located outside of the quarantine area, culled fruit must be:

   a.) moved to an approved landfill under PPQ or State cooperator supervision,

   b.) moved back to the quarantine area for immediate use as animal feed, or

   c.) other approved mitigations applied.

   Note: Culls will include damaged green and breaker fruits, and a small percentage of riper fruits.

System Alternative Two – This system applies to growers who harvest tomatoes riper than breakers including cherry and grape tomato varieties, and various types of round tomatoes that are packed and generally sold for wholesale distribution. This can also include certified producers that harvest fruit for immediate sale at certified farmer markets by the producer (or his agent). This would apply to tomatoes grown within the quarantine area, but not within the chemical treatment zone (200 to 400 meter radius).

1. The growers/packers need to sign a Compliance Agreement (CA) with the state department of agriculture.
2. The grower must participate in a regulatory trapping program on the grower’s production site.

3. Regulatory trapping requirements:

   a. Tomatoes grown within the quarantine area excluding the core square mile area, regulatory traps must be in place for at least 7 days prior to harvest.

   b. Tomatoes produced in the core square mile area excluding the chemical treatment zone (200 to 400 meter radius around a given find as required by the Action Plan), regulatory traps must be in place for 30 days prior to harvest.

4. If the commercial growers move their product to a packing house outside the quarantine area, any culls would be subject to the same requirements as in **Systems Alternative One**.

Notes:

1. Regulatory trapping will consist of 2 traps per 5 acres (ac) with at least two traps per tomato growing site. One of the traps (per 5 ac or per growing sites) should utilize a Trimedlure and the other should use a food lure (3 component lure or torula yeast pellets). The two traps should be placed at separate locations from each other. Regulatory trapping in an area subject to either SIT or aerial bait spray can be reduced by one half using the trap that is most conducive to the treatment strategy.

2. An evaluation of the local situation will be required prior to initiation of a compliance agreement. Compliance agreements will stipulate the systems approach requirements.

3. Tomatoes will be allowed to move out of a Medfly quarantine area for processing (i.e. canning) under compliance agreements with appropriate safeguards as stated in the compliance agreement.

4.2. Summary of Risk

As stated in section II, **Low Pest Prevalence** and **Poor host status** are the independent measures (major components) of the systems approach based on: 1.) high density of delimitation traps in service within the quarantine area (much greater than the density used for general detection purposes or within defined Medfly-free areas), and 2.) Immediate implementation of emergency response measures that include fruit stripping, ground treatments, aerial treatments

(SIT or bait sprays) and regulatory control of host material moving from areas under quarantine, the area qualifies as a **Low Pest Prevalence Area.** In addition, fresh tomatoes will not be shipped from any areas close to sites where Medfly is detected (within 200 to 400 meters). Green and breaker stages of tomatoes cannot be moved until regulatory trapping is in place for at least 7 days prior to harvest. Green tomatoes are not considered a host by USDA and no records occur of mostly green or pink tomatoes be found infested apart from forced infestation under laboratory conditions. Riper tomatoes could not be moved until regulatory trapping is in place for at least 30 days prior to harvest.

The poor host status of tomatoes is clearly indicated by the lack of interception records of Medfly at US ports of entry and the complete absence of Medfly-infested tomatoes during fruit sampling and cutting during outbreaks in the continental US. In addition, the published literature and forced infestation results under laboratory conditions further indicates its poor host status. Records of field infestation are limited to ripe tomatoes collected from backyards or small truck farmers.

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7. APPENDICES

Appendix A. Relative density of Medfly within a quarantine area

Empirical data from previous outbreaks in California and Florida show a high probability of additional Medflies being captured in the core area (generally one sq. mile) compared to surrounding buffer areas due to higher trap densities during delimitation. Unless the trap density is very great (i.e. 1,000 traps /sq. mile) they should not compete with each other thus you can estimate the relative density of Medfly in the core area compared to the surrounding buffer.

Miller and Chang (1995) examined captures from 10 selected Medfly outbreaks occurring in California and Florida between 1987 and 1993 (Table 1).

Table 1. Calculating relative fly density using fly capture/traps from prior outbreaks (1984 -1993)

Selected outbreaks	Trimedlure Traps						All Traps					
	Core		1st Buffer		Outer Buffer		Core		1st Buffer		Outer Buffer	
	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps
California												
Los Angeles 1987	22	100	7	400	1	1200	30	125	8	440	4	1560
West L.A. 1988	29	100	5	400	4	1200	38	150	5	440	4	1560
Northridge 1988	2	100	0	400	0	1200	24	125	0	440	2	1560
Mountain View 1989	21	100	0	400	0	1200	24	125	0	440	0	1560
Country Club Park 1991	19	1100	2	400	0	1320	21	1200	2	480	0	2040
Oceanside 1992	1	1000	0	400	0	1320	1	1110	0	440	0	1680
San Jose 1992	119	1050	0	400	0	1200	122	1075	0	440	0	1560
Granada Hills 1993	46	1000	9	400	7	2160	46	1025	9	440	8	2520
Florida												
Miami 1984	6	100	1	400	7	1200	6	113	1	508	0	1200
Miami Springs 1990	14	100	6	400	0	1200	16	105	6	440	0	1560
Total	279	4750	30	4000	19	13200	328	5153	31	4508	18	16800
Flies/trap	0.0587		0.0075		0.00144		0.0637		0.00688		0.00107	
Flies/trap relative to core	1		0.128		0.0245		1		0.108		0.0168	

Results strongly indicate that at very high densities (1,000 traps/ sq. mi) traps compete with each other for capture of a limited number of flies. Table 2 shows that captures per trap within the core area registered 0.0446 flies per trap (1,000-traps/sq. mi) compared to 0.1567 at 100-traps/sq. mi densities. Flies per trap for the 1st buffer and outer buffer showed no significant difference. At lower trap densities, increased traps proportionally increases the number of flies captured. For example, doubling traps from 10 to 20 per square mile would presumably double total fly capture, but captures per trap would remain the same. For this reason, the 4 outbreaks with high density trapping in the core were eliminated from further assessment.

Table 2. Comparing capture rates with trap density from trimedlure-baited traps from prior outbreaks (1984 -1993)

Outbreaks	Core			1st buffer			Outer core		
	No. Flies		No. Traps	No. Flies		No. Traps	No. Flies		No. Traps
Six outbreaks with 100 traps/core	94		600	19		2400	12		7200
Flies/traps		0.1567			0.0079			0.00167	
Relative captures to core		1			0.05			0.01066	
Four outbreaks with from 1000 - 1100 traps/core	185		4150	11		1600	7		6000
Flies/traps		0.0446			0.0069			0.00117	
Relative captures to core		1			0.1547			0.0262	
All 10 outbreaks	279		4750	30		4000	19		13200
Flies/traps		0.0587			0.0075			0.00144	
Relative captures to core		1			0.128			0.0245	

Miller and Chang determined that the probability of capturing an additional fruit fly in a trap was 20 times greater in the core than in the first buffer and 100 times greater than the outer buffers. Using this probability, one can assume that fruit fly hosts situated in buffer areas are 20 -100 times lower risk from Medfly infestation compared to those found in the core. To confirm the difference in risk between the core and buffer areas, fly captures from 10 additional Medfly outbreaks occurring in between 1994 and 2009 were examined (see Table 3). The data indicate that the probability of capturing an additional fruit fly in a trap was 33 times greater in the core than in the first buffer and 1000 times greater than the outer buffer.

To estimate the relative density of Medflies in core and the buffers from outbreaks occurring between 1984 to 1993 used only data for Trimedlure-baited traps. However, data from recent outbreaks used total captures from all types of traps because of the greater use of food-base lures.

Table 3. Calculating relative fly density using fly capture/traps from prior outbreaks (1994 -2009)												
Selected outbreaks (California)	Trimedlure Traps						All Traps					
	Core		1st Buffer		Outer Buffer		Core		1st Buffer		Outer Buffer	
	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps	No. flies	No. traps
Camarillo 1994	61	100		400		1200	62	125	1	440		1560
Walnut Park 1997*	9	40	1	60		800	19	80	3	180		1200
Lake Forest 1998	3	100	1	400		1040	4	110	2	480	1	1560
La Jolla Area 1998	2	100		400		1040		110		480		1560
Hyde Park 2001*		40		80		880		140	1	120		1320
Dixon 2007	6	100	1	400		1200	9	125		600		1560
San Jose 2007	2	100		400		1200		125		600		1560
El Cajon 2008	1	100	1	400		1200	2	125	7	600		1560
San Diego 2009		100		400		1200	4	125		600		1560
Fullbrook 2009		100		400		1200	2	125		600		1560
Total	84	880	4	3340		10960	102	1190	14	4700	1	15000
Flies/trap	0.0954		0.0012		0		0.0857		0.00298		0.0000667	
Flies/trap relative to core	1		0.0126		0		1		0.0348		0.000778	
* = The core during these outbreaks were 4 square miles in area and was with in the Preventive Release area												

Outbreaks between 1987 and 2010 were not included in the assessment if one or more of the below conditions applied:

- No addition Medflies were captured after an outbreak was triggered since this would not provide needed data.
- The quarantine area contained more than one core area. We would not know from which core the flies originated from
- Two or more outbreaks occurred in a relative small area. We would not be sure from which outbreak the flies originated from.
- 1,000 traps/ sq. mi or more were used in the core. The large number of traps in the core would compete with each other.

Appendix B. Registered pesticides used for commercial tomato production in Florida (Table 8 below, Olson et al , 2011, Vegetable production Handbook for Florida 2011).

{note: chemicals highlighted in yellow are also used for fruit fly control although specific formulations have not been evaluated for tephritid fruit flies}

Table 8. Selected insecticides approved for use on insects attacking tomatoes.

Trade Name (Common Name)	Rate (product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
Acramite-50WS (bifenazate)	0.75-1.0 lb	12	3	twospotted spider mite	un	One application per season.
Actara (thiamethoxam)	2.0-5.5 oz	12	0	aphids, flea beetles, leafhoppers, stinkbugs, whitefly	4A	Maximum of 11 oz/acres per season. Do not use following a soil application of a Group 4A insecticide.
Admire Pro (imidacloprid) (for rates for other brands, see labels)	7-10.5 fl oz	12	21	aphids, Colorado potato beetle, flea beetles, leafhoppers, thrips (foliar feeding thrips only), whitefly	4A	Most effective if applied to soil at transplanting. Admire Pro limited to 10.5 fl oz/acre.
Admire Pro (imidacloprid)	0.6 fl oz/1000 plants	12	0 (soil)	aphids, whitefly	4A	Greenhouse Use: 1 application to mature plants, see label for cautions.
Admire Pro (imidacloprid)	0.44 fl oz/10,000 plants	12	21	aphids, whitefly	4A	Planthouse: 1 application. See label.
Agree WG (*Bacillus thuringiensis* subspecies *aizawai*)	0.5-2.0 lb	4	0	armyworms, hornworms, loopers, tomato fruitworm	11	Apply when larvae are small for best control. Can be used in greenhouse. OMRI-listed[2].
***Agri-Mek 0.15EC** (abamectin)	8-16 fl oz	12	7	broad mite, Colorado potato beetle, *Liriomyza* leafminers, spider mite, *Thrips palmi*, tomato pinworm, tomato russet mite	6	Do not make more than 2 sequential applications. Do not apply more than 48 fl oz per acre per season.
***Ambush 25W** (permethrin)	3.2-12.8 oz	12	up to day of harvest	beet armyworm, cabbage looper, Colorado potato beetle, granulate cutworm, hornworms, southern armyworm, tomato fruitworm, tomato pinworm	3	**Do not use on cherry tomatoes.** Do not apply more than 1.2 lb ai/acre per season (76.8 oz). Not recommended for control of vegetable leafminer in Florida.
***Asana XL (0.66EC)** (esfenvalerate)	2.9-9.6 fl oz	12	1	beet armyworm (aids in control), cabbage looper, Colorado potato beetle, cutworms, flea beetles, grasshoppers, hornworms, potato aphid, southern armyworm, tomato fruitworm, tomato pinworm, whitefly, yellowstriped armyworm	3	Not recommended for control of vegetable leafminer in Florida. Do not apply more than 0.5 lb ai per acre per season, or 10 applications at highest rate.
Assail 70WP (acetamiprid)	0.6-1.7 oz	12	7	aphids, Colorado potato beetle, thrips, whitefly	4A	Do not apply to crop that has been already treated with imidacloprid or thiamethoxam at planting. Begin applications for whitefly when first adults are noticed. Do not apply more than 4 times per season or apply more often than every 7 days.
Assail 30 SG	1.5-4.0 oz					
Avaunt (indoxacarb)	2.5-3.5 oz	12	3	beet armyworm, hornworms, loopers, southern armyworm, tomato fruitworm, tomato pinworm, suppression of leafminers	22	Do not apply more than 14 ounces of product per acre per crop. Minimum spray interval is 5 days.
Aza-Direct (azadirachtin)	1-2 pts, up to 3.5 pts, if needed	4	0	aphids, beetles, caterpillars, leafhoppers, leafminers, mites, stink bugs, thrips, weevils, whitefly	un	Antifeedant, repellant, insect growth regulator. OMRI-listed[2].
Azatin XL (azadirachtin)	5-21 fl oz	4	0	aphids, beetles, caterpillars, leafhoppers, leafminers, thrips, weevils, whitefly	un	Antifeedant, repellant, insect growth regulator.

Table 8. Continued.

Trade Name (Common Name)	Rate (product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
***Baythroid XL** (beta-cyfluthrin)	1.6-2.8 fl oz	12	0	beet armyworm[(1)], cabbage looper, Colorado potato beetle, dipterous leafminers[(2)], European corn borer, flea beetles, hornworms, potato aphid, southern armyworm[(1)], stink bugs, tomato fruitworm, tomato pinworm, variegated cutworm , western flower thrips, whitefly adults[(2)]	3	[(1)] 1st and 2nd instars only [(2)] Suppression Do not apply more than 0.132 lb ai per acre per season.
Belay 50 WDG (clothianidin)	1.6-2.1 oz	12	7	aphids, Colorado potato beetle, flea beetles, leafhoppers, leafminers (suppression), Lygus, stink bugs, whiteflies (suppression)	4A	Do not apply more than 6.4 oz per acre per season. Do not use an adjuvant. Toxic to bees. Do not release irrigation water from the treated area.
Belay 50 WDG (clothianidin)	4.8 -6.4 oz (soil application)	12	Apply at planting	aphids, Colorado potato beetle, flea beetles, leafhoppers, leafminers (suppression), Lygus, foliar feeding thrips, whiteflies (suppression)	4A	Do not apply more than 6.4 oz per acre per season. See label for application instructions. Do not release irrigation water from the treated area.
Beleaf 50 SG (flonicamid)	2.0-2.8 oz	12	0	aphids, plant bugs	9C	Do not apply more than 8.4 oz/acre per season. Begin applications before pests reach damaging levels.
Biobit HP (*Bacillus thuringiensis* subspecies *kurstaki*)	0.5-2.0 lb	4	0	caterpillars (will not control large armyworms)	11	Treat when larvae are young. Good coverage is essential. Can be used in the greenhouse. OMRI-listed[2].
BotaniGard 22 WP, ES (*Beauveria bassiana*)	**WP:** 0.5-2 lb/100 gal **ES:** 0.5-2 qt 100/gal	4	0	aphids, thrips, whitefly	--	May be used in greenhouses. Contact dealer for recommendations if an adjuvant must be used. Not compatible in tank mix with fungicides.
***Brigade 2EC** (bifenthrin)	2.1-5.2 fl oz	12	1	aphids, armyworms, corn earworm, cutworms, flea beetles, grasshoppers, mites, stink bug spp., tarnished plant bug, thrips, whitefly	3	Make no more than 4 applications per season. Do not make applications less than 10 days apart.
CheckMate TPW-F (pheromone)	1.2-6.0 fl oz	0	0	tomato pinworm	--	For mating disruption - See label.
Confirm 2F (tebufenozide)	6-16 fl oz	4	7	armyworms, black cutworm, hornworms, loopers	18	Product is a slow-acting IGR that will not kill larvae immediately. Do not apply more than 1.0 lb ai per acre per season.
Coragen (rynaxypyr)	3.5-7.5 fl oz	4	1	beet armyworm, Colorado potato beetle, fall armyworm, hornworms, leafminer larvae, loopers, southern armyworm, tomato fruitworm, tomato pinworm	28	Can be applied by drip chemigation or as a soil application at planting. See label. For hornworms, can use as little as 2.0 fl oz/acre when applied as a foliar spray.
Courier 40SC (buprofezin)	9.0-13.6 fl oz	12	1	leafhoppers, mealybugs, planthoppers, whitefly nymphs	16	Apply when a threshold is reached of 5 whitefly nymphs per 10 leaflets from the middle of the plant. Product is a slow-acting IGR that will not kill nymphs immediately. No more than 2 applications per season. Allow at least 5 days between applications.

Table 8. Continued.

Trade Name (Common Name)	Rate (product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
Fulfill (pymetrozine)	2.75 oz	12	0 - if 2 applica-tions 14 - if 3 or 4 applica-tions	green peach aphid, potato aphid, suppression of whitefly	9B	Do not make more than four applications. (FL-040006) 24(c) label for growing transplants also (FL-03004).
Intrepid 2F (methoxyfenozide)	4-16 fl oz	4	1	beet armyworm, cabbage looper, fall armyworm, hornworms, southern armyworm, tomato fruitworm, true armyworm, yellow-striped armyworm	18	Do not apply more than 64 fl oz per acre per season. Product is a slow-acting IGR that will not kill larvae immediately.
Javelin WG (*Bacillus thuringiensis* subspecies *kurstaki*)	0.12-1.5 lb	4	0	most caterpillars, but not *Spodoptera* species (armyworms)	11	Treat when larvae are young. Thorough coverage is essential. OMRI-listed[2].
Knack IGR (pyriproxyfen)	8-10 fl oz	12	1	immature whitefly	7C	Apply when a threshold is reached of 5 nymphs per 10 leaflets from the middle of the plant. Product is a slow-acting IGR that will not kill nymphs immediately. Make no more than two applications per season. Treat whole fields.
Kryocide (cryolite)	8-16 lb	12	14	armyworm, blister beetle, cabbage looper, Colorado potato beetle larvae, flea beetles, hornworms, tomato fruitworm, tomato pinworm	un	Minimum of 7 days between applications. Do not apply more than 64 lbs per acre per season.
***Lannate LV, *SP** (methomyl)	**LV:** 1.5-3.0 pt **SP:** 0.5-1.0 lb	48	1	aphids, armyworm, beet armyworm, fall armyworm, hornworms, loopers, southern armyworm, tomato fruitworm, tomato pinworm, variegated cutworm	1A	Do not apply more than 21 pt LV/acre/crop (15 for tomatillos) or 7 lb SP/acre/crop (5 lb for tomatillos).
Malathion 5 **Malathion 8 F** (malathion)	1.0-2.5 pt 1.5-2 pt	12	1	aphids, *Drosophila*, mites	1B	Can be used in greenhouse (8F).
***Monitor 4EC** (methamidophos) [24(c) labels] FL-800046 FL-900003	1.5-2 pts	96	7	aphids, fruitworms, leafminers, tomato pinworm(1), whitefly(2)	1B	(1) Suppression only (2) Use as tank mix with a pyrethroid for whitefly control. Do not apply more than 8 pts per acre per crop season, nor within 7 days of harvest.
Movento (spirotetramat)	4.0-5.0 fl oz	24	1	aphids, psyllids, whitefly	23	Maximum of 10 fl oz/acre per season.
M-Pede 49% EC (Soap, insecticidal)	1-2% V/V	12	0	aphids, leafhoppers, mites, plant bugs, thrips, whitefly	--	OMRI-listed[2].
***Mustang** (zeta-cypermethrin)	2.4-4.3 oz	12	1	beet armyworm, cabbage looper, Colorado potato beetle, cutworms, fall armyworm, flea beetles, grasshoppers, green and brown stink bugs, hornworms, leafminers, leafhoppers, *Lygus* bugs, plant bugs, southern armyworm, tobacco budworm, tomato fruitworm, tomato pinworm, true armyworm, yellow-striped armyworm. Aids in control of aphids, thrips and whitefly.	3	Not recommended for vegetable leafminer in Florida. Do not make applications less than 7 days apart. Do not apply more than 0.3 lb ai per acre per season.

Table 8. Continued.

Trade Name (Common Name)	Rate (product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
Requiem 25EC (extract of Chenopodium ambrosioides)	2-4 qt	4	0	chili thrips, green peach aphid, *Liriomyza* leafminers, melon thrips, potato aphid, western flower thrips, silverleaf whitefly	un	Begin applications before pests reach damaging levels. Limited to 10 applications per crop cycle.
Rimon 0.83EC (novaluron)	9-12 fl oz	12	1	armyworms, Colorado potato beetle, foliage feeding caterpillars, loopers, tomato fruitworm, tomato hornworm, tomato pinworm, stink bugs, thrips, whiteflies	15	Do not apply more than 36 fl oz per acre per season. Minimum of 7 days between applications.
Sevin 80S; XLR; 4F (carbaryl)	**80S:** 0.63-2.5 **XLR; 4F:** 0.5-2.0 A	12	3	Colorado potato beetle, cutworms, fall armyworm, flea beetles, lace bugs, leafhoppers, plant bugs, stink bugs[(1)], thrips[(1)], tomato fruitworm, tomato hornworm, tomato pinworm, sowbugs	1A	[(1)] suppression Do not apply more than seven times. Do not apply a total of more than 10 lb or 8 qt per acre per crop.
10% Sevin Granules (carbaryl)	20 lb	12	3	ants, centipedes, crickets, cutworms, earwigs, grasshoppers, millipedes, sowbugs, springtails	1A	Maximum of 4 applications, not more often than once every 7 days.
SpinTor 2SC (spinosad)	1.5-10.0 fl oz	4	1	armyworms, Colorado potato beetle, flower thrips, hornworms, *Liriomyza* leafminers, loopers, *Thrips palmi*, tomato fruitworm, tomato pinworm	5	Do not apply to seedlings grown for transplant. Leafminer and thrips control may be improved by adding an adjuvant. Do not make more than two consecutive applications. Do not apply more than 29 oz per acre per crop.
Sulfur (many brands)	See label	24	see label	tomato russet mite, twospotted spider mite	--	May burn fruit and foliage when temperature is high. Do not apply within 2 weeks of an oil spray or EC formulation.
Synapse WG (flubendiamide)	2-3 oz	12	1	armyworms, hornworms, loopers, tomato fruitworm	28	Do not apply more than 9 oz/acre per season.
***Telone C-35** (dichloropropene + chloropicrin) ***Telone II** (dichloropropene)	See label	5 days (See label)	preplant	garden centipedes (symphylans), wireworms	--	See supplemental label for restrictions in certain Florida counties.
***Thionex EC** (endosulfan)	0.66-1.33 qt	48	2	aphids, blister beetle, cabbage looper, Colorado potato beetle, flea beetles, hornworms, stink bugs, tomato fruitworm, tomato russet mite, whitefly, yellowstriped armyworm	2	Do not exceed a maximum of 2.0 lb active ingredient per acre per season or apply more than 4 times. Can be used in greenhouse. No available label for this product at this time. Use ends 2014.
Trigard (cyromazine)	2.66 oz	12	0	Colorado potato beetle (suppression of), leafminers	17	No more than 6 applications per crop. Does not control CPB adults. Most effective against 1st & 2nd instar larvae.
Trilogy (extract of neem oil)	0.5-1.0% V/V	4	0	aphids, mites, suppression of thrips and whitefly	un	Apply morning or evening to reduce potential for leaf burn. Toxic to bees exposed to direct treatment. Do not exceed 2 gal/acre per application. OMRI-listed[2].

Table 8. Continued.

Trade Name (Common Name)	Rate (product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
Ultra Fine Oil, Saf-T-Side, others **JMS Stylet-Oil** (oil, insecticidal)	1-2 gal/100 gal 3-6 qt/100 gal water (JMS)	4	0	aphids, beetle larvae, leafhoppers, leafminers, mites, thrips, whitefly, aphid-transmitted viruses (JMS)	--	Do not exceed four applications per season. Organic Stylet-Oil and Saf-T-Side are OMRI-listed[2].
Venom Insecticide (dinotefuran)	**foliar:** 1-4 oz **soil:** 5-6 oz	12	**foliar:** 1 **soil:** 21	Colorado potato beetle, flea beetles, leafhoppers, leafminers, thrips, whitefly	4A	Use only one application method (soil or foliar). Limited to three applications per season. Toxic to honeybees.
Vetica (flubendiamide and buprofezin)	12.0-17.0 fl oz	12	1	armyworms, cabbage looper, cutworms, garden webworm, suppression of leafhoppers and mealybugs, saltmarsh caterpillar, tobacco budworm, tomato hornworm, tomato fruitworm, tomato pinworm, suppression of whiteflies	28, 16	Do not apply more than 3 times per season or apply more than 38 fl oz per acre per season. Same active ingredients as Synapse, Coragen, and Courier.
Voliam Flexi (thiamethoxam, chlorantraniliprole)	4-7 oz	12	1	aphids, beet armyworm, Colorado potato beetle, fall armyworm, flea beetles, hornworms, leafhoppers, loopers, southern armyworm, stink bugs, tobacco budworm, tomato fruitworm, tomato pinworm, whitefly, yellowstriped armyworm, suppression of leafminer	4A, 28	Do not use in greenhouses or on transplants. Do not use if seed has been treated with thiamethoxam or if other Group 4A insecticides will be used. Highly toxic to bees. Do not exceed 14 oz per acre per season, or 0.172 lb ai of thiamethoxam-containing products or 0.2 lb ai of chlorantraniliprole-containing products per acre per season.
***Vydate L** (oxamyl)	**foliar:** 2-4 pt	48	3	aphids, Colorado potato beetle, leafminers (except *Liriomyza trifolii*), whitefly (suppression only)	1A	Do not apply more than 32 pts per acre per season.
***Warrior II** (lambda-cyhalothrin)	0.96-1.92 fl oz	24	5	aphids(1), beet armyworm(2), cabbage looper, Colorado potato beetle, cutworms, fall armyworm(2), flea beetles, grasshoppers, hornworms, leafhoppers, leafminers(1), plant bugs, southern armyworm(2), stink bugs, thrips(3), tomato fruitworm, tomato pinworm, whitefly(1), vegetable weevil adults, yellowstriped armyworm(2)	3	(1) suppression only (2) for control of 1st and 2nd instars only. Do not apply more than 0.36 lb ai per acre per season. (3)Does not control western flower thrips.
Xentari DF (*Bacillus thuringiensis* subspecies *aizawai*)	0.5-2 lb	4	0	caterpillars	11	Treat when larvae are young. Thorough coverage is essential. May be used in the greenhouse. Can be used in organic production. OMRI-listed[2].

The pesticide information presented in this table was current with federal and state regulations at the time of revision. The user is responsible for determining the intended use is consistent with the label of the product being used. Use pesticides safely. Read and follow label instructions.

Table 8. Continued.

Trade Name (Common Name)	Rate (product/acre)	REI (hours)	Days to Harvest	Insects	MOA Code[1]	Notes
Neemix 4.5 (azadirachtin)	4-16 fl oz	12	0	aphids, armyworms, hornworms, psyllids, Colorado potato beetle, cutworms, leafminers, loopers, tomato fruitworm (corn earworm), tomato pinworm, whitefly	un	IGR, feeding repellant. OMRI-listed[2].
NoMate MEC TPW (pheromone)		0	0	tomato pinworm	--	For mating disruption - See label.
Oberon 2SC (spiromesifen)	7.0-8.5 fl oz	12	1	broad mite, twospotted spider mite, whiteflies (eggs and nymphs)	23	Maximum amount per crop: 25.5 fl oz/acre. No more than 3 applications.
Platinum **Platinum 75 SG** (thiamethoxam)	5-11 fl oz 1.66-3.67 oz	12	30	aphids, Colorado potato beetles, flea beetles, leafhoppers, thrips, tomato pinworm, whitefly	4A	Soil application. See label for rotational restrictions. Do not use with other neonicotinoid insecticides
Portal (fenpyroximate)	2.0 pt	12	1	mites, including broad mites	21A	Do not make more than two applications per growing season.
***Pounce 25 W** (permethrin)	3.2-12.8 oz	12	0	beet armyworm, cabbage looper, Colorado potato beetle, dipterous leafminers, granulate cutworm, hornworms, southern armyworm, tomato fruitworm, tomato pinworm	3	Do not apply to cherry or grape tomatoes (fruit less than 1 inch in diameter). Do not apply more than 0.6 lb ai per acre per season.
***Proaxis Insecticide** (gamma-cyhalothrin)	1.92-3.84 fl oz	24	5	aphids(1), beet armyworm(2), blister beetles, cabbage looper, Colorado potato beetle, cucumber beetles (adults), cutworms, hornworms, fall armyworm(2), flea beetles, grasshoppers, leafhoppers, plant bugs, southern armyworm(2), spider mites(1), stink bugs, thrips(1), tobacco budworm, tomato fruitworm, tomato pinworm, vegetable weevil (adult), whitefly(1), yellowstriped armyworm(2)	3	(1) Suppression only. (2) First and second instars only. Do not apply more than 2.88 pints per acre per season.
***Proclaim** (emamectin benzoate)	2.4-4.8 oz	12	7	beet armyworm, cabbage looper, fall armyworm, hornworms, southern armyworm, tobacco budworm, tomato fruitworm, tomato pinworm, yellowstriped armyworm	6	No more than 28.8 oz/acre per season.
Provado 1.6F (imidacloprid)	3.8-6.2 fl oz	12	0	aphids, Colorado potato beetle, leafhoppers, whitefly	4A	Do not apply to crop that has been already treated with imidacloprid or thiamethoxam at planting. Maximum per crop per season 19 fl oz per acre.
Pyrellin EC (pyrethrin + rotenone)	1-2 pt	12	12 hours	aphids, Colorado potato beetle, cucumber beetles, flea beetles, flea hoppers, leafhoppers, leafminers, loopers, mites, plant bugs, stink bugs, thrips, vegetable weevil, whitefly	3, 21	
Radiant SC (spinetoram)	5-10 fl oz.	4	1	armyworms, Colorado potato beetle, flower thrips, hornworms, *Liriomyza* leafminers, loopers, *Thrips palmi*, tomato fruitworm, tomato pinworm	5	Maximum of 34 fl oz per acre per season.

Appendix C. Summary of Published Findings on Host Status of Tomatoes

A large number of scientific articles have been published concerning host plants of Medfly, the most notable by Liquido *et al.* (1998), called MEDHOST, consists of an encyclopedic bibliography of the host plants of Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (electronic database program). In 2013, MEDHOST was revised as version 1.1 and available online (Liquido, *et al., 2013).* MEDHOST uses 109 published and unpublished documents and consists of 374 entries including common and botanical names. It also summarizes field and/or laboratory infestation data or, in the absence of infestation data shows questionable hosts as "listed only".   MEDHOST contains 27 entries for tomato, 5 contain data concerning field infestations (one with negative findings only) and most of the others were "listed only". Laboratory infestation data is addressed below in III.A.4. Every effort was made to obtain clear evidence concerning field infestation.

In addition to MEDHOST, a general review was conducted using online databases, the USDA National Agriculture Library, APHIS libraries and other sources. Below is information obtained from MEDHOST, results from general literature review, and subsequent inquiries for more details or other questions concerning content.

1. Publications Concerning Field Infestation Data – All documents found that gave field data information concerning *Solanum lycopersicum* L. (Common tomato) and Medfly are listed and discussed below:

- **Notes on the Embargo of Grapes for Almería, Spain, on Account of the Mediterranean fruit-fly (*Ceratitis capitata* Wied.)** (Leonard, 1925):

After grapes imported into the United States from Almería, Spain in 1923 were found infested with Medfly at the ports of New York and Boston, subsequent shipments were embargoed. M. L. Leonard, an Entomologist from Ithaca, New York was sent to Spain by the New York Fruit Exchange. He visited Almería, Spain between May 13 and Sept 10, 1924 to study the Medfly infestation in the grape growing area. During June and early August he found peach, apricot, pear, quince, orange, and tomato infested in that order based on degree of infestation. Later in August figs became heavily infested with Medfly. He did not find grapes infested.

Concerning tomatoes, “only one fruit containing one larva was found during the whole season.” Tomatoes were not grown commercially in the area. They were grown in small gardens for home use. It is assumed that the infested fruit was found infested from external inspection and fruit cutting. No mention of fruits being held to allow for the insect to mature from the larval stage. We assume that the agent that infested the fruit was Medfly because no other fruit fly occurring in Spain would likely be infesting this set of fruits. This is the earliest publication that the authors found showing evidence of field infestation of tomatoes.

- **Host Plants of Mediterranean fruit fly on the Island of Hawaii (1949 -1985 Survey).** (Liquido *et al*., 1990):

Fruit were collected between 1949 and 1985 on the island of Hawaii and held to try to rear Medfly adults. The collections were done to determine the infestation biology in various hosts and to support other field ecology studies for Medfly conducted by ARS-USDA in Hilo. “The database developed from this survey consists of 13,423 records (collections) with a total of 953,660 fruits collected. Of the 196 fruit species collected, 60 are Mediterranean fruit fly hosts under natural field conditions.” The collections of fruit were “randomly selected” from the plants “however, there were numerous instances when ripe fruits on ground were also collected.”

They made 266 collections of tomato fruits. Five of the collections (1.88 %) produced adult Medfly. The total fruits collected were 8,691. The 5 infested collections produced an average of 22.54 adult Medfly/kg of fruit. There were a total of 64 fruits in the 5 infested collections.

Tomatoes were sampled from small gardens for grower personal use or from small mixed produce truck farms for local sales, not from large commercial tomato farms with packinghouses that export out of state.

- **Ecology of *Bactrocera latifrons* (Diptera: Tephritidae) Populations: Host Plants, Natural Enemies, Distribution, and Abundance.** (Liquido *et al*., 1994):

In this study, ARS-USDA Hilo conducted field sampling to determine host plants, natural enemies, distribution, and abundance of an exotic fruit fly, *Bactrocera latifrons* in Hawaii. On the Islands of Hawaii and Maui from July 1990 and Oct. 1992 they collected a large number of fruit samples from various solanaceous and cucurbitaceous host plants. “At least 50 fruits per species were collected per sampling occasion.” The collections were then held and the recovered larvae and pupae identified. All four of Hawaii's introduced fruits flies (melon fly, oriental fruit fly, Medfly and *B. latifrons*) were recovered. Data from tomatoes and a related plant species is given in Table 1. This included:

- *Solanum (Lycopersicon) lycopersicum* L. – Common tomato
- *Solanum (Lycopersicon) lycopersicum* L. var. *cerasiforme* (Alef.) – Cherry tomato
- *Solanum (Lycopersicon) pimpinellifolium* L. – Currant tomato

Many currant tomato collections came from "natural habitats" while common tomato collections came from "commercial and dooryard situation."

The commercial situation mentioned above is from small mixed produce truck farms for local sale, not from tomato farms with packinghouses. Currant tomatoes are mentioned here for completeness only but is not part of the assessment.

Table 1.

Common Name/Location	From	No. of collections	# fruits	# kg	# Fruit Flies Recovered	# Medflies Recovered
Common tomato/ Island of Hawaii	plant	23	541	28.57	177	0
- Same -	ground	11	403	23.40	43	0
Common tomato/ Island of Maui	plant & ground	7	246	14.54	20 (plant) 18 (ground)	0 0
Cherry tomato/ Island of Hawaii	plant	38	1715	13.54	194	1
- Same -	ground	30	1477	9.43	42	0
Cherry tomato/ Island of Maui	plant	8	462	4.11	81	1
- Same -	ground	13	543	4.36	7	0
Currant tomato/ Island of Hawaii		16	1946	2.66	49	3
Currant tomato, Island of Maui		7	249	0.28	1	0

The current distribution (and during the 1990's) of Medfly on both these islands is/was restricted because of competition from oriental fruit fly and the lack of preferred host plants in some locations thus there were no breeding populations of Medfly near many of the collection sites (Liquido et al., 1990).

- **New Host Records for Mediterranean Fruit Fly in Western Australia**. (Jenkins, 1955)

Jenkins states that three new Medfly hosts were reported for Western Australia during the autumn of 1955 including tomato (*L. esculentum*). The Australian find was from a single ripe tomato from a metropolitan grocer's shop. Two Medfly and four tomato flies (*Lonchaea* sp.) were reared and identified. The market garden where the fruit was grown was inspected but no additional Medflies were found. In this paper Jenkins cites a quote taken from Bodenheimer (1951), "With regard to vegetables, there is one report of tomatoes (*L. esculentum*) having been attacked 15 years ago in Palestine." Among Jenkins' references, he lists - Bodenheimer, F. S. (1951) – "Citrus Entomology," Hoitsema Bros.; Groningen (Holland) 1951, p. 116. Authors were unable to find any records of tomato infestation by Medfly from any Palestine source.

2. <u>Publications and other Documents that List Tomato as a Host or Possible Host of Medfly but not providing Field or Laboratory Data</u> – These documents give some useful insights into the host status of *Solanum lycopersicum* L. (Common tomato) for Medfly. These documents are listed and discussed below:

- **A Manual of Dangerous Insects likely to be introduced in the United States through Importation.** (Pierce, 1917)

This document gives distribution and hosts (with no details or comments) of exotic plant pests. For Medfly, it lists *Lycopersicon esculentum* (tomato) as a host.

- **The Mediterranean fruit fly and its economic impact on Central American countries and Panama.** (Mitchell, 1977)

This document has a large annotated host list for Medfly in an Appendix. This report cites literature sources for each host and it identified the host as being in one of the following groups: 1) heavily or generally infested, 2) occasionally infested, 3) rarely infested, and 4) laboratory. They placed *Solanum lycopersicum* L. (Tomato) under the occasionally infested group.

- **Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann). Entomology Circular 230**. (Weems, 1981)

This is a data sheet type publication with a large annotated host list. Weems divides the host list into groups: 1) heavily or generally infested, 2) occasionally infested, 3) rarely infested, 4) laboratory infestations, and 5) unknown importance. He placed them into groups based on the "best available information." He placed *Solanum lycopersicum* L. (tomato) under the occasionally infested group.

- **Mediterranean Fruit Fly, *Ceratitis capitata* (Wiedemann) (Insecta: Diptera: Tephritidae). IFAS Extension. (**Thomas *et al*., 2005)

This is a data sheet type publication with a large annotated host list. They divide the host list into the same groups as Weems (1982). They placed *Solanum lycopersicum* L. (Tomato) under the same group, the occasionally infested group.

- **Fruit Flies of Economic Significance: Their Identification and Bionomics.** (White and Elson-Harris, 1992)

This 601 page book gives mainly data sheet type information for all the economic significant fruit fly of the world. It has a large annotated host list. Under *Lycopersicon esculentum* Miller (tomato), Medfly is listed as "*Ceratitis (Ceratitis) capitata* (Wiedemann)? and the symbol "?" is defined in the host list as "Possible or likely host, but only known from old records; not confirmed by any known recent survey authoritative data source."

- **Pests not known to occur in the United States or of limited distribution, No. 26: Mediterranean fruit fly. (** PNKTO, 1982)

This document is a data sheet type publication with a host list (with no details or comments) of the host of Medfly. It list *Lycopersicon esculentum* (tomato) as a host.

- **The Mediterranean fruit fly. USDA Circular 160**. (Quaintance, A. L. 1912)

This 25 page document lists "Tomato" as a host for Medfly. In the text, he reports that Medfly attacked 18 hosts including pumpkin, bananas, pineapple and tomato in Victoria, Australia based from information from Mr. C. French, Journal of Agriculture, May, 1897.

- **The Mediterranean fruit fly in Hawaii. USDA Bulletin 536**. (Back, E. A. & C. E. Pemberton. 1918)

This 120 page document lists "*Lycopersicon esculentum* (tomato)" as a host of Medfly in Hawaii and classifies tomato as an occasional host. On page 38, it states, "several samples of tomato fruit collected in Hawaii from 1911 to 1916 no Medfly was recovered". They report Medfly was easily recovered from tomatoes under forced laboratory conditions.

- **The distribution and host plants of fruit flies (Diptera: Tephritidae) in Australia. Department of Primary Industries, Queensland, Information Series Q199067: 1-75.** (Hancock DL, Hamacek EL, Lloyd AC, Elson-Harris MM, 2000).

This 75 page document gives the distribution and known Australian hosts of species of Tephritidae occurring in Australia. Under Medfly, "*Solanum lycopersicum* (tomato)" is listed with the comment "over ripe only".

3. <u>A Large Recently Published Document that does not List Tomato as a Host or Possible Host of Medfly</u> – The selected document is assumed to give some useful insight into the real host status of *Solanum lycopersicum* L. (Common tomato) for Medfly.

- **Annotated check list of host plants for Afrotropical fruit flies (Diptera: Tephritidae) of the genus *Ceratitis.*** (De Meyer et al., 2002)

This 91page paper is a large annotated host list for all Afrotropical representatives of the genus *Ceratitis*. The data are based on museum specimens, recent collecting efforts and literature, and both confirmed and questionable records are provided. The data only reflects African collected material. *Ceratitis. catoirii, C. pedestris* and *C. rosa* were listed as being reared from *Lycopersicon esculentum* but not Medfly.

Appendix D. Fruit Cutting Results during Medfly Outbreaks in the continental US

Tomatoes have never been found infested during an outbreak in the continental US. Larva infestation data was report for all Medfly outbreaks occurring in the US mainland where Medfly infested fruit was found. The number of larval properties in the hosts involved was report for the one outbreak in Texas (15 properties) (Table 4), for all outbreaks in California (539 properties) (Table 3), and for the outbreaks in Florida since 1997 (34 properties) (Table 2). This is a total of 588 recorded larval properties. In the earlier outbreaks occurring in Florida only the hosts found infested was reported, not the number of time found infested (Table 1). At least 32 host taxa were reported infested with Medfly. Apricot, sweet orange and peach were the most commonly reported hosts found infested. At least during the recent outbreaks, fruit cutting of reported hosts around the trap captures of Medfly was the norm.

Table 1 Mediterranean Fruit Fly Larval Properties in Florida by Host, 1929-87

The year is not listed below if no larval properties were found that year.

Host	*1929*	*1956*	*1963*	*1984*	*1987*
Calamondin			X**		1*
Grapefruit	X*	X*			
Orange cvs., early			X**		
Persimmon			X**		
Sour orange				1*	
Tangerine			X**		

X denotes unknown number of larval properties.

* Clark and Weems 1989.

** Microfilmed records for Florida located in the APHIS Information Center, Riverdale, MD, reported as heavy infestations or high populations, insect stage unspecified.

Table 2. Mediterranean Fruit Fly Larval Properties in Florida from 1988-2011:

The year is not listed below if no larval properties were found that year.

Year	Location	# Larval Properties	Number of Larvae/Host
1997	Hillsborough Co.	19	Total larvae 373: grapefruit, orange, & tangerine
1997	Manatee Co., Palmetto	1	1 – grapefruit
1997	Polk Co., Highland City	3	22 – grapefruit
1998	Highlands Co., Sebring	2	18 – grapefruit
1998	Lake Co., Umatilla	2	66 – sour orange
1998	Manatee Co., Bradenton	8	61 – grapefruit
1998	Manatee Co., Altoona	1	12 – sour orange
1998	Miami-Dade Co., Miami Springs	1	5 – grapefruit
2010	Palm Beach Co., Boca Raton	2	10 – sour orange; 1 – cattley guava
	Total Larval Properties	**34**	

Source: David Dean, USDA, APHIS, PPQ, Florida, Sept. 2012

Table 3 **Mediterranean Fruit Fly Larval Properties in California by Host, 1975-2011**

The year is not listed below if no larval properties were found that year.

Host	1975	1980	1981	1987	1988	1989	1990	1992	1993	1994	1997	1998	2001	2005	2007	2008	2009	**All**
Apple		11							1			1		2				**15**
Apricot		24	146															**170**
Avocado		1																**1**
California-laure		1																**1**
Calamondin		1				1	1										2	**5**
Cherry		1																**1**
Fig		4	2			1									1			**8**
Grapefruit		1	1		2				3			2	1			1		**11**
Guava		2	1			1		1	1		4					1		**11**
Guava, Mexican								1			6							**7**
Guava, Pineapple		6																**6**
Guava, Strawberry		2	1			1												**4**
Kumquat		3			1	1	2								1		1	**9**
Lemon, Meyer		8	2			2			1									**13**
Lime												1						**1**
Lime, Rangpur		1																**1**
Loquat	1	4	1															**6**
Orange, Sweet		28			4	7		1		14	1							**55**
Orange, Sour									1									**1**
Mandarin			1															**1**
Nectarine		12	5					3	4									**24**
Peach	13	55	21	1		10		23	20			1			2			**146**
Peach, Indian		1																**1**
Pear		4	1															**5**
Pear, Sand												1						**1**
Pepper, Sweet		1																**1**
Persimmon		12			1	3						1						**17**
Plum		1	3						1									**5**
Quince		1																**1**
Tangelo		1																**1**
Tanerine			1						1								1	**3**
Walnut		2																**2**
Unspecified		1	4															**5**
TOTAL	**14**	**189**	**190**	**1**	**8**	**27**	**3**	**29**	**33**	**14**	**11**	**7**	**1**	**2**	**4**	**2**	**4**	**539**

Source: Mike Stefan,USDA, APHIS in Dec. 1993 and CDFA for 1994 to 2011 data (July 2012)

Table 4 - Mediterranean Fruit Fly Larval Properties in Texas by Host, 1966

Host	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
Calamondin						1							1
Peach						9	4						13
Sour Orange						1							1
Total						11	4						15

Source: Microfilmed identification records for Texas located in the APHIS Information Center, Riverdale, MD.

A question can be asked, 'how often are tomatoes cut during outbreaks?' We were able to only obtain four reports of fruit cutting that listed the type of fruit cut where no larva were found. These all were from California. A summary of these reports are included here. In one outbreak 2.6% (28.5 lb.) of the total fruit cut was tomatoes. In one outbreak no tomatoes were cut. In another outbreak tomatoes were cut but the amount not recorded. In the last outbreak, only one of the cut fruits, lemons, were reported by name.

Summary of Fruit Cutting Results For Several Medfly Detections in California

Below is a compilation of fruit cutting results for several Medfly detections in California showing the types of fruit sampled. Comprehensive information on this subject has not always been collected and is not retrievable electronically. The summary indicates that tomato fruits were sampled on several occasions. **Comments** below are those of the authors of this document, not from the source reports.

1. Rancho Cucamonga

The fruit cutting report(s) cover from: Aug. 20, 2012 to Aug. 25, 2012

Number of days fruit were cut: 6 days
Total properties with fruit cutting: 69
Total LBS of fruit cut: 1,109 LBS
Total LBS of tomato fruits cut: **28.5 LBS**

Comments: 1) Tomatoes were cut 5 out of the 6 days of the fruit cutting; 2) 2.6 % of the fruit cut were tomatoes; and 3) at least 24 species of fruit were cut including other poor/marginal/non-host such as lemon, avocado, pepper, eggplant, blackberry, and lime.

2. San Diego

The fruit cutting report(s) cover from: May 22, 2009

Number of days fruit were cut: 1 day

Total LBS of fruit cut: 6.75 LBS

Total LBS of tomato fruits cut: **0.0 LBS**

Comments: Types of fruit cut were loquat, apricot, peach, apple, calamondin, lemon, and orange

3. Spring Valley

The fruit cutting report(s) cover from: Feb. 10, 2009 to Feb. 18, 2009

Number of days fruit were cut: not in report

Total properties with fruit cutting: 8

Total LBS of fruit cut: 237 LBS

Total LBS of tomato fruits cut: **not recorded**

Comments: 21 LBS of the fruit cut included lemons. Other fruit cut was not reported as type.

4. El Cajon

The fruit cutting report(s) cover from: Nov. 13, 2008 to Jan 30, 2009

Number of days fruit were cut: about 30 days

Total properties with fruit cutting: 320

Total LBS of fruit cut: 4,690 LBS

Total LBS of tomato fruits cut: **Not reported – the host was cut only once**

Comments: 1) The majority of fruit cut was *Citrus*. Other types of fruit cut included apple, cherry guava, Mexican guava, pear, persimmon, pomegranate, and sapote.

Appendix E. - Laboratory Infestation data [Hawaii]

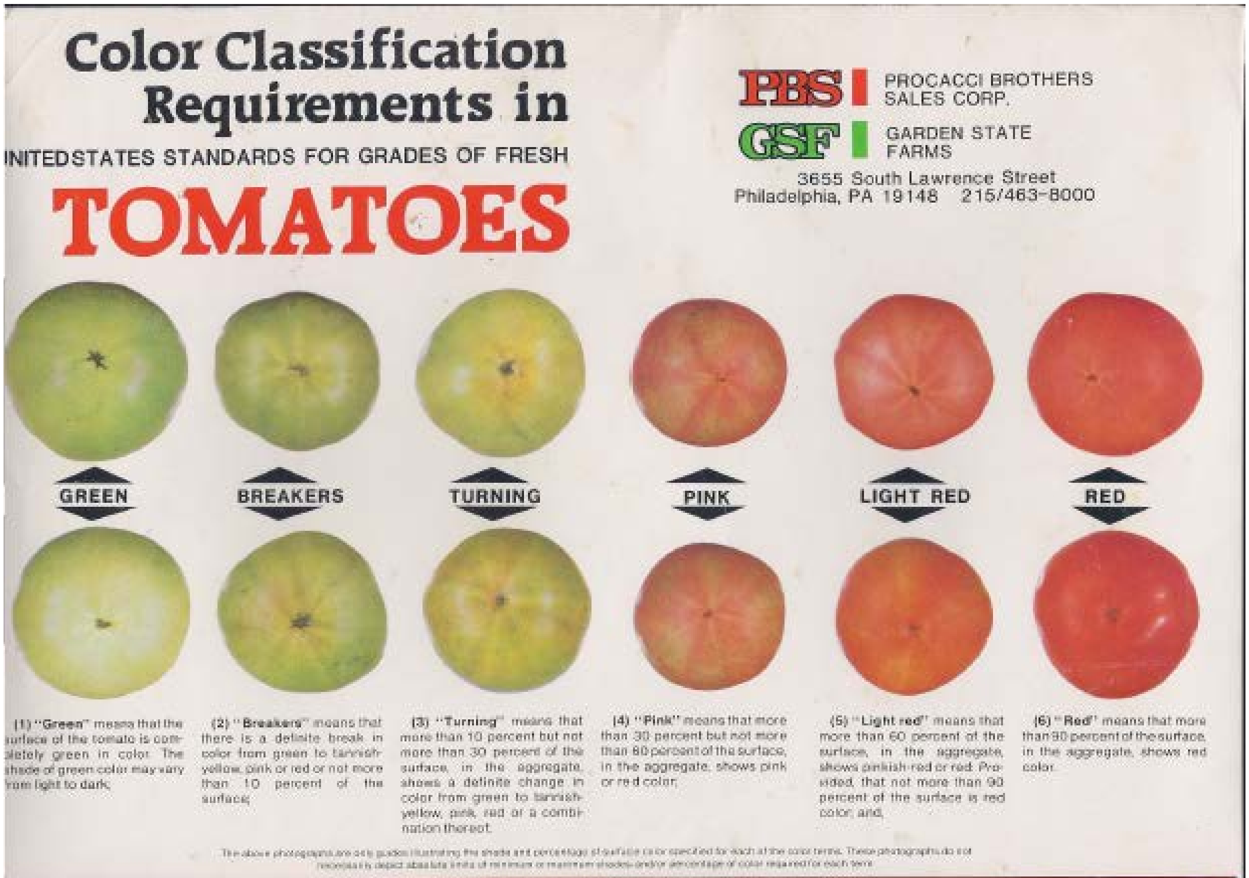
A series of laboratory and field cage tests were performed to determine corroborate information in the literature and in reports from other countries testing host status of Medfly on tomatoes. Information below report the results of these tests using lab-reared Medfly from Hawaii. The tests were not meant to be all-inclusive but to demonstrate current host status of Medfly using Hawaiian-grown tomatoes.

Insects

Mediterranean fruit fly pupae were obtained from the Pacific Basin Agricultural Research Center's rearing facility in Hilo, Hawaii. Pupae were allowed to emerge in 33 cm cube screened aluminum cages and given water, sugar and protein. Cages were held in a 12:12 L/D cycle, 75° F, 65% RH insect holding room.

Tomatoes

Beefsteak tomatoes were obtained from a commercial tomato grower in the Big Island of Hawaii. Tomatoes were grown under open-ended shade houses and tomatoes used for the study selected from the red colored spectrum according to US standards color classification requirements for grades of fresh tomatoes. They are an indeterminate variety. Pink is classified as 30% but not more than 60% shows pink or red color. Light red is classified as more than 60% but less than 90% of the surface shows pinkish-red or red color. Red is classified as more than 90% of the surface shows a red color (Figures 1a and 1b). Tomatoes selected for infestation were not more than 8 hours off the vine.



Beefsteak tomatoes were selected from the green colored spectrum according to US standards color classification requirements for grades of fresh tomatoes. The above color chart mirrors the USDA color chart for round tomatoes. Green is classified as a completely green surface with varying shades of green. Breakers are classified as a definite break in color from green to yellow, with no more than 10% pink or red. Turning is classified as 10% but not more than 30% definite change in color from green to yellow, pink and red combinations (Fig 2). Tomatoes selected for infestation were not more than 8 hours off the vine or freshly picked.

Fig.1a

Fig.1b

Fig. 2

Forced Infestation

Beefsteak tomatoes were obtained from Hamakua Springs Farm on the island of Hawaii. Six tomatoes (each average weight approximately 164g) were placed in a wooden infestation cage (61cm x 41cm x 32cm) containing 60 female med flies, ages 5-10 days old. Flies were allowed to infest tomatoes for 24 hours, at 77° F and 66.3% RH with a 12:12 L/D cycle. At the end of the infestation period the tomatoes were removed and placed in individual buckets (15cm high, 14.5cm diameter). Buckets were held in a fruit screening room. Three non-infested tomatoes were held as controls. Since flies of the same stock culture were used in production of fruit flies used in the colony, we determined that a positive control to show that flies were gravid and could produce eggs were not needed since flies produced many eggs for the colony. Tomatoes were checked at 11, 14 and 18 days for pupae. Pupae were held until emergence. Emerged and un-emerged pupae were recorded. A total of 270 tomatoes were exposed to fruit flies.

Field Cage Infestation

Choice infestation tests were conducted in a mesh field cage 15m by 6m by 2.4m.Tomatoes were placed in a wire mesh box that measured 12cm X 12cm X 11cm. Each box containing one tomato was hung on a potted plant in each corner and two were placed in the center towards the edge of the cage. Sixty female flies 5-10 days old were released in the center of the cage. After 24 hours the tomatoes were placed in individual buckets (14cm diameter tapered to 11cm x 14cm tall with a 9cm screened opening in the cover. The bucket contained sand and a metal screen shelf to allow liquid to drain out of the bottom. Three un-infested tomatoes were held as controls. The buckets were held in a fruit holding room at ambient temperatures.

Tomatoes were checked and screened for pupae on day eleven, fourteen, and eighteen. Pupae were counted and kept in a separate container, and dry sand was replaced on each day of service. Both the tomatoes and the pupae were held in the fruit holding room. The test was terminated at day 18. Adult fly emergence was counted and recorded. A total of 60 tomatoes were exposed to fruit flies.

Table 1. Forced infestation of red colored spectrum of tomatoes

Color Class	Reps	# Tomatoes	Infested	Not infested	Mean # pupae	Mean # emerged	% Emergence
Pink	1	6	5	1	41	22	52
	2	6	6	0	91	51	56
	3	6	6	0	46	28	62
	4	6	3	3	7	6	88
	5	6	4	2	20	15	72
	6	6	4	2	28	18	65
	7	6	5	1	41	15	36
Total		**42**	**33**	**9**	**39**	**21**	**54**
Light Red	1	6	6	0	29	20	70
	2	6	6	0	38	27	71
	3	6	5	1	120	70	58
	4	6	2	4	2	1	64
	5	6	5	1	23	17	73
	6	6	5	1	34	22	67
	7	6	5	1	38	17	44
Total		**42**	**34**	**8**	**40**	**24**	**60**
Red	1	6	3	3	22	16	71
	2	6	6	0	29	16	55
	3	6	6	0	72	39	54
	4	6	6	0	14	9	64
	5	6	5	1	48	22	45
	6	6	6	0	88	53	61
	7	6	6	0	32	22	69
Total		**42**	**38**	**4**	**43**	**25**	**58**

Table 2. Forced infestation of green color gradient of tomatoes.

Color Class	Reps	# Tomatoes	# Infested	# Non-infested	Mean # pupae	Mean # emerged	% Emergence
Green	1	6	6	0	23	14	61
	2	6	4	2	37	25	68
	3	6	3	3	8	8	90
	4	6	4	2	18	10	58
	5	6	6	0	28	25	90
	6	6	0	6	0	0	00
	7	6	3	3	5	4	96
	8	6	3	3	8	8	100
Total		**48**	**29**	**19**	**15**	**12**	80
Breaking	1	6	5	1	17	14	82
	2	6	3	3	10	9	92
	3	6	1	6	0	0	0
	4	6	5	1	9	6	65
	5	6	3	3	8	8	98
	6	6	4	2	11	8	72
	7	6	4	2	32	22	68
	8	6	2	4	2	1	60
Total		**48**	**27**	**22**	**11**	**8**	76
Turning	1	6	6	3	42	26	61
	2	6	6	0	105	74	71
	3	6	3	0	50	40	80
	4	6	4	0	25	11	45
	5	6	6	1	159	101	64
	6	6	5	0	44	29	66
	7	6	6	0	109	70	64
	8	6	4	2	10	5	53
Total		**48**	**40**	**6**	**68**	**44**	65

Table 3. Choice infestation test

Color Class	Reps	# Tomatoes	#Infested	# Non-infested	Mean # pupae	Mean # emerged	% Emergence
Green	1	2	0	2	0	0	0.00
	2	2	0	2	0	0	0.00
	3	2	0	2	0	0	0.00
	4	2	0	2	0	0	0.00
	5	2	0	2	0	0	0.00
	6	2	0	2	0	0	0.00
	7	2	1	1	3	3	100
	8	2	0	2	0	0	0.00
	9	2	0	2	0	0	0.00
	10	2	0	2	0	0	0.00
Total		**20**	**1**	**19**	**0.3**	**0.3**	100
Pink	1	2	2	0	9	5	50
	2	2	1	1	12	12	96
	3	2	0	2	0	0	0.00
	4	2	0	2	0	0	0.00
	5	2	0	2	0	0	0.00
	6	2	1	1	1	1	100
	7	2	2	0	137	89	65
	8	2	2	0	27	9	32
	9	2	0	2	0	0	0.00
	10	2	0	2	0	0	0.00
Total		**20**	**8**	**12**	**19**	**11**	62
Red	1	2	2	0	45	24	52
	2	2	2	0	39	35	91
	3	2	0	2	0	0	0.00
	4	2	1	1	2	0	0.00
	5	2	1	1	1	0	0.00
	6	2	2	0	28	4	13
	7	2	2	0	44	24	53
	8	2	2	0	83	45	54
	9	2	2	0	26.5	20	75
	10	2	1	1	14.5	7	48
Total		**20**	**15**	**5**	**28**	**16**	56

Results

All red color gradients of tomatoes were infested by Mediterranean fruit fly. In forced infestation studies, 33 out of 42 pink tomatoes were infested, 34 out of 42 light red tomatoes were infested and 38 out of 42 red tomatoes were also infested. There were not any differences in the rate of infestation among the red color spectrum of tomatoes (Fig 3). Results of the green, breaking and turning color scale showed higher infestation rates on turning class of tomatoes compared to breaking and green. With green tomatoes 29 out of 48 were infested, 27 out of 48 breaking color tomatoes were infested and 40 out of 48 turning colored tomatoes were infested under forced conditions (Fig 4). In choice field cage tests, green tomatoes had 1out of 20 tomatoes infested, 8 out of 20 pink colored tomatoes were infested and 15 out of 20 red colored tomatoes were infested when given a selection (Fig 5).

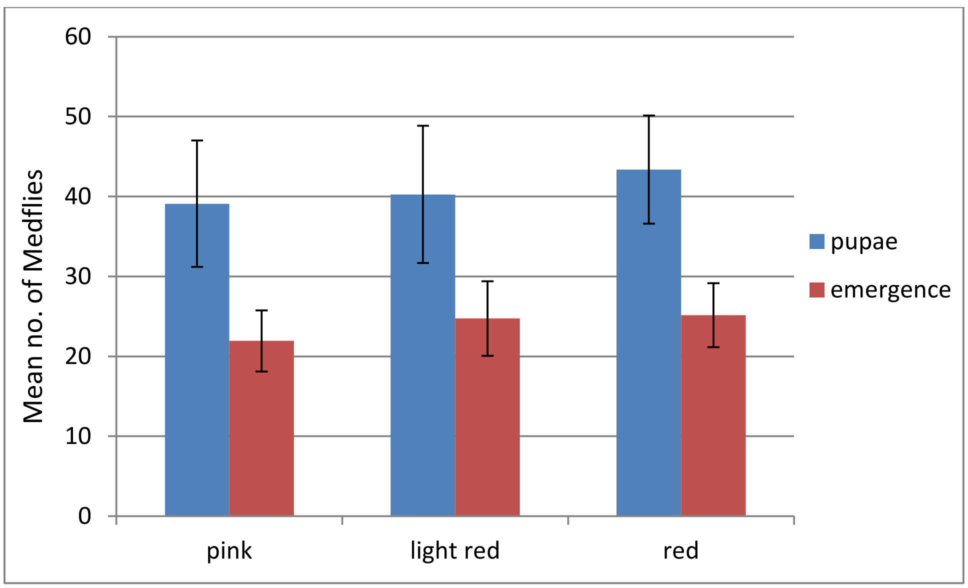


Fig.3 Results of Medfly recovery from forced infestation of 3 red ripeness stages of Hawaii grown tomatoes. There were no Medflies recovered from the (uninfested) controls.

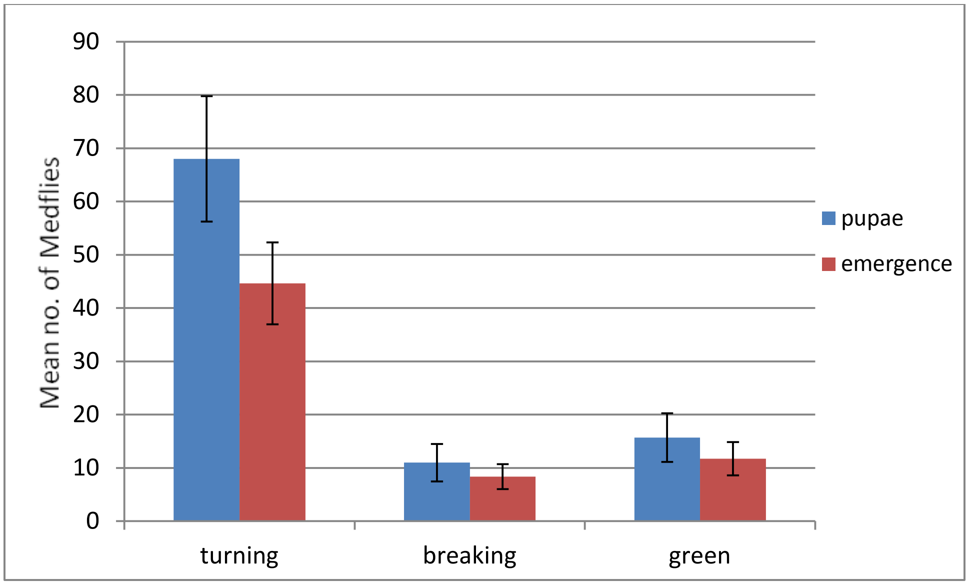


Fig. 4 Results of Medfly recovery from forced infestation of 3 green ripeness stages of Hawaii grown tomatoes. There were no Medflies recovered from the (uninfested) controls.

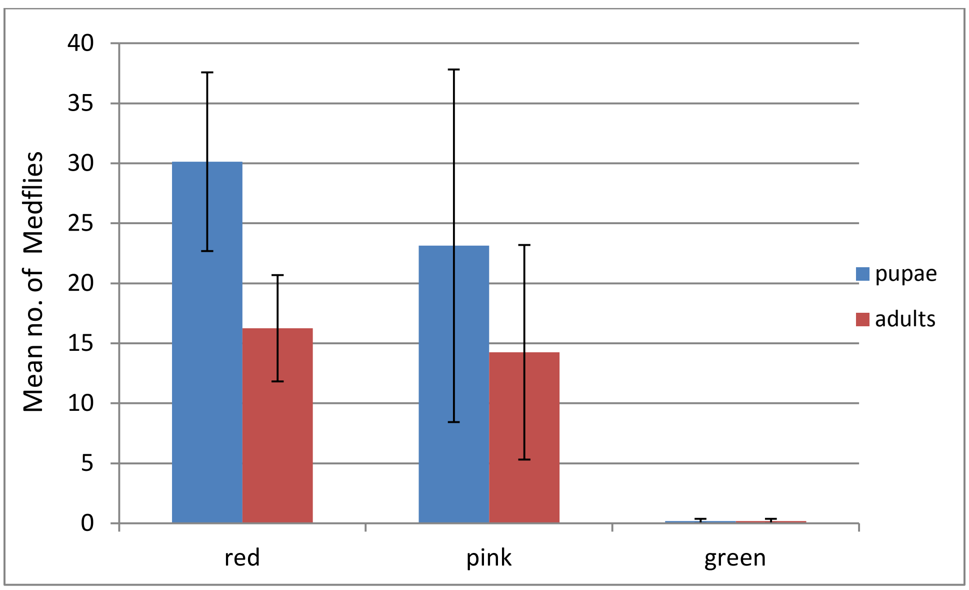


Fig. 5 Results of field cage infestation choice test comparing red, pink and green tomatoes.

There were no Medflies recovered from the (uninfested) controls.

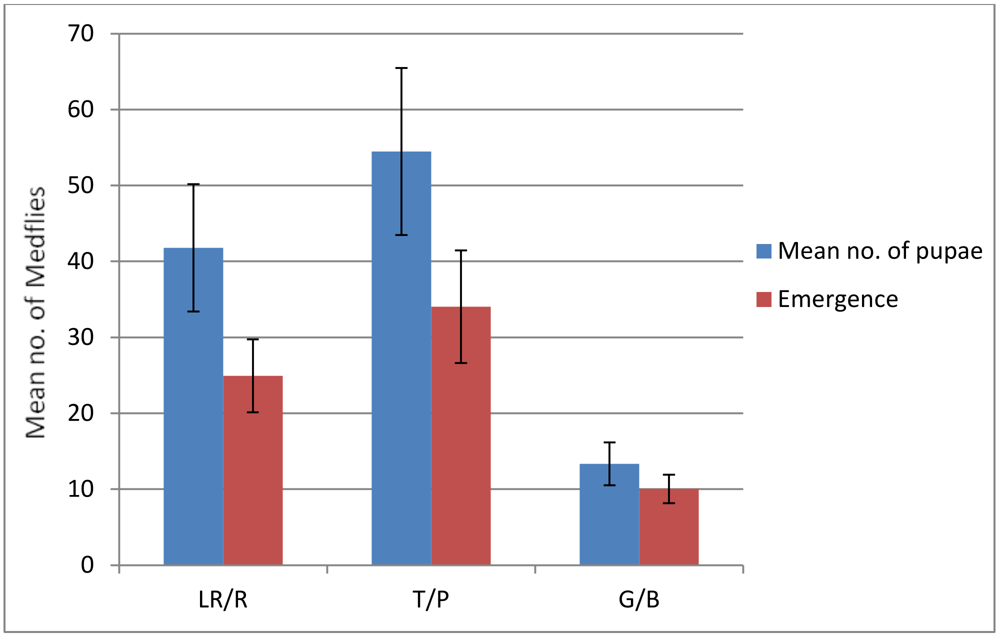


Fig. 6 Forced Infestation of three combined color classes of tomatoes.

Conclusion

The results of both forced infestation studies and open field cage infestations showed that this variety of tomato is considered an occasional to rare host of Medfly depending on the variety and color class. While our studies showed infestation is possible at all color classes (mostly in no-choice lab infestation with laboratory reared flies, there was a trend for more infestation as fruit ripened, especially in the choice tests where flies were able to choose among different ripeness of tomatoes. Previous studies have also classified tomatoes as an occasional -rare host for Medfly (Back and Pemberton 1918, Weems 1981, Liquido 1990). The conditions under which forced infestation take place makes it more favorable for gravid female fruit flies to elicit ovipositional behavior, which can result in more infestation that would normally occur under natural field conditions. Additionally we used laboratory-reared flies for all studies which may be different from wild-type flies in their propensity to infest and lay eggs in various substrates. Other studies (Back and Pemberton 1918) corroborated the observation that tomatoes can be force infested but that in choice tests, infestation is greatly reduced. In a larger field cage environment, fruit flies were allowed to be more selective in determining a host to lay eggs in. Also if a rare infestation occurs, multiple eggs will be laid in one fruit versus one egg in multiple fruit. This will lessen the probability of the distribution of an infested fruit. On vine studies were not carried out but planned to determine if our result are in line with those reported by others. Several factors may be responsible for the difference between reports in the literature and ours including the source of flies used, infestation pressure, variety of tomato used in the study and environmental conditions. However overall we believe that tomatoes are a poor host of Medfly.

While the exact reasons for the progressive susceptibility of tomatoes to Medfly infestation are not precisely known, a study by Chan and Tam (1985) looked at levels of the chemical alpha-tomatine in laboratory reared Medflies and showed a strong correlation between the level of this chemical in the diet (and in fruit) and development. Tomatoes have many chemicals that may also be involved in resistance mechanisms in this fruit to Medfly infestation.

Appendix F. Site Visits to Florida and California

1. Notes on December 2011 Trip to Florida to Visit the Tomato Production Sites

During December 2011 Eric Jang and Ed Miller visit tomato production sites in Florida (FL) and with persons from the State and Federal plant protection agencies located in FL. Ground transportation and much program subject expertise were provided by Dr. David Dean, CPHST, USDA, Sarasota, FL., for our visit. In addition, Abbie Jo Fox, Assistant Bureau Chief, Bureau of Methods Development & Biological Control, Division of Plant Industry (FDACS) organized the visits to the production sites, traveled with us to these sites, and met with us and others at the Thursday meeting in Gainesville. We are very indebted to both of them. Many of the others we met and helped us are identified in the attachment.

During the trip we visited three packinghouses and three farms, from Immokalee in southern FL to Rustin, FL in central FL. Concerning FL production we were told and/or observed that:

A. GENERAL

- Almost 100% of the FL production is sold 'fresh' packed in cartons or clam shells. Some of these are later repacked at other facilities (in-state or out-of-state) or processed for fresh use by the retail food industry.
- Almost all of the FL production is sold in the Eastern United States and Canada. Almost no other exports.
- The basic types of tomato fruits produced in FL are **round tomato** (The largest portion of the production), **Roma tomato,** and **cherry tomato** (This represent 20 – 25% of the production and includes **grape tomato**).
- There may be no "Pick-your-own" industry in FL. and the grow-to-sell on the road side stand/ farmer market industry is small compared to total production. Also they may not be affected by the quarantine.

B. FIELD

- About 99% of production is in the open field, about 1% or less is greenhouse. The greenhouse is mostly bunch (round) tomatoes. Generally the farms are large; the ones we visited were from 300 to 6000 ac. in size.
- In FL most (99 %+) of the production of tomato plants are staked, both the determinate or indeterminate plants.

- The irrigation systems are generally drip irrigation, gravity feed ditch, or a combination of both systems.

- **Round Tomatoes –** They are generally determinate plants, in most varieties they are most commonly harvested as green (stage 1 based on the USDA color chart), about 95% of harvest. An additional -/+ 5% as breakers (stage 2) and possibly as stage 3 (turning) . The same day or the following they are cleaned, culled and packed in the packinghouse. Those that are too small, above stage 2, or are damaged are culled. The cartons of green are placed in a cold room with ethylene gas to start the ripening process. The breakers (stage 2) are placed in cold room without ethylene. The tomatoes stay in the chambers until they reach the ripeness stage required by the individual buyers and then shipped in refrigerated containers. The determinate plants are harvested 2 to 3 times over about a 6 week period.

  Ugly tomatoes are a type of round tomato that is ribbed and somewhat flattened. In FL they grow indeterminate plants that are harvested as stage 2 and 3 (possibly as stage 4, pink), and picked 15 or 20 times over a long period. One or more other varieties of round tomatoes are under development that will be picked riper as is ugly tomatoes.

- **Roma Tomatoes -** They are determinate plants and are grown and packed similar to round tomatoes but are commonly picked riper (up to stage 4, pink).

- **Cherry Tomatoes including grape tomatoes -** They are indeterminate plants. It appears that grapes are grown more commonly than the other cherry types. They are picked mostly as pinks (stage 4) or light reds (stage 5 and 6). They are harvested 20 to 30 times in the season. At the packinghouse they are packed in cartons or in clam shells. One popular type packed here was yellow when ripe.

- Harvested tomatoes are removed from the field to the packinghouse in flat-bed tractor and trailers. It appears that the greener products are moved in large tubs (two per trailer), large field boxes (about 22 per trailer), or gondola (bulk) trailers; and the riper products in small field boxes.

- In the same general area of the tomato farms sweet citrus is commonly grown.

- The employees that picked the fruit are paid by the volume they harvest. They are hired for the season.

- The harvest season in FL is between November and May.

- Fallen fruit may or may not be left in the field.

C. PACKINGHOUSE

- It is normal that the culls from the packinghouses are used as farm animal food. They are dumped in open pastures.
- The packinghouses might pack only for their farms, or for their farms and others. The fields can be a large distance from their packinghouse, possibly 50 miles or more.
- In one packinghouse they selected at least one box out of 200 boxes to inspect for quality control. In another packinghouse, they sampled one box every 15 min. for their quality control. Round tomatoes are constantly inspected as required by the USDA Marketing Order.
- The cold storage rooms may be located within the packinghouse, next to it in another building or several miles from the packinghouse.
- Above are generalizations but within the industry there are many differences with field and packinghouse practices. For example, in one packinghouse all of or much of the fruit would arrive from the field in small field boxes and placed in a large cool room for up to 10 days before they are packed. The fruit would ripen to some degree here before they were packed, thus even the round tomatoes might be packed as pinks.

D. Factors in the production and packing process that affects the risk of FL tomatoes as a host of Medfly

1. A large percentage of FL production of tomatoes are harvested as green or as more green than pink (stage 1, 2, or 3). Most of these are packed within 36 hours and then stored in cold rooms until they are shipped.

2. The industry employ a large number of people whose main duty is to cull out tomatoes that are not the right size, too ripe, scarred or damaged. The number of people culling tomatoes seems greater than in other fruit packinghouses. The effective culling of riper fruit or damaged fruit (scarred?) would lower the risk by removing fruit that are more likely to be infested.

3. The three packinghouses that we visited and several others that we drove by during the week were large, in an urban setting, with large parking lots around them, and mostly closed up (but not fly proof). No host material was observed growing close by.

4. Several of the insecticides used in the field for whiteflies and other pests should also cause a certain degree of mortality for fruit flies.

E. Chronology of Tomato Production and Postharvest Review - Florida, Dec. 12 - 17, 2011

<u>Monday, Dec. 12th</u>

AM *Ed Miller and Eric Jang arrived in Sarasota, FL*

PM Meeting with Dr. David Dean, CPHST, USDA

<u>Tuesday, Dec. 13th</u>

9:15 – Meet at IFAS Research Center 2685 SR 29N Immokalee, FL

Met with and travel this day with Matthew Brodie, DPI, (FDACS)

10:00 Gargiulo LP – field production of tomatoes

David Pensabene Farm Manager 239-641-5760

1:30 AgMart - field production of specialty tomatoes

Kris Carlson 5275 Camp Keais Rd Immokalee, FL 239-825-1384

4:00 SixL's *–packinghouse visit - Immokalee*

<u>Wednesday, Dec. 14th</u>

9:00am Meet at USDA Fruit Fly Office

Colonial Plaza 915 10th Street East Palmetto, FL 34221 Main Office (941) 723-8910

Overview of Florida Tomato Production

Reggie Brown - Florida Tomato Committee and Executive Vice President of the Florida Tomato Exchange

Steve Sargent, Professor, Horticultural Sciences UF/IFAS

DiMare Fresh – Field and Packinghouse operations Tony DiMare, Ruskin, FL.

AgMart Packinghouse – Specialty tomato packing - Tony Mazza, 4006 Airport Rd. Plant City, FL. 813-545-3370

<u>Thursday, Dec. 15th</u>

10:00 Meet at FDACS DPI, 1911 SW 34th St Gainesville, FL

Meet with, Wayne N. Dixon, Ph.D. Assistant Director (FDACS), Paul Hornby, State Plant Health Director (USDA), Edward Cusano, Fruit Fly Director , FL (USDA), Dr. David Dean, Abbie Jo Fox, (FDACS)

Afternoon – Met with USDA *- Paul Hornby, State Plant Health Director (USDA) and Edward Cusano at Paul Hornby's office*

<u>Friday, Dec. 16th</u>

Review and Planning meeting *between Ed Miller and Eric Jang*

2. Notes on July 2012 Site Visit to California Tomato Production Area

A. GENERAL

- A large amount of the CA tomato production is for processing. This is outside the scope of this project since this can currently move for processing from or into a quarantine area with safeguards and without treatment.
- The basic types of fresh tomato fruits produced in CA are **round tomato** (The largest portion of the production), Roma tomato**,** cherry tomato and some heirlooms.
- About 99% of production is in the open field, about 1% or less is greenhouse.
- The irrigation systems are generally drip irrigation or gravity feed ditch systems.
- Several of the insecticides used in the field for whiteflies and other pests should also cause a certain degree of mortality of fruit flies.

B. LARGE COMMERCIAL GROWERS

We visited two packinghouses and one farm that grows for one of these packinghouses. The large packinghouses receive tomatoes from farms that they own or lease, and others are under contracts with the growers. These farms may be a great distance from the packinghouse. The two we visited received tomatoes from throughout the Central Valley. They pack only mature greens (stage 1 based on the USDA color chart) and breakers (stage 2). The same day or the following they are cleaned, culled, and packed in cartons. The great majority are packed the same day. Those that are too small, above stage 2, or are damaged are culled. They can cull around 30 percent of the fruit received. The cartons of green are placed in a cold room with ethylene gas to start the ripening process. The breakers (stage 2) are placed in cold rooms without ethylene. The tomatoes stay in the chambers until they reach the ripeness stage required by the individual buyers and then shipped in refrigerated containers. These are sold throughout the United State and Canada.

On the farm, they plant determinate bush tomatoes and harvest only once. Their objective is to harvest only mature greens and breakers. A large percent of the tomatoes, small greens and tomatoes riper than breakers, remain in the field and are later worked into the soil.

The majority of tomatoes packed by the large packers are round tomatoes but can also be Roma tomatoes. The Roma tomatoes are handled the same way in the packinghouse and on the farm.

Currently the culls are removed from the packinghouses daily and are either spread on pasture land and fed to cattle immediately, or piled up and stored for future use for dairy cows. Currently the culls are used locally close to the packinghouse.

The two packinghouses that we visited were large, in an urban setting, with large parking lots around them, and mostly closed up (but not fly proof). No host material was observed growing close by, but backyard fruit would be in the area.

C. MEDIUM SIZE COMMERIAL PRODUCERS

We visited two medium size producers, both farming about 500 ac. of various fruit and vegetables or just vegetables, and both having a small packinghouse on the farm. The field culls were left in the fields and the packinghouse culls were composted on the farm or disposed of locally.

The one producer grows about 10 to 15 ac. of round (indeterminate) staked tomatoes. These are harvested about 20 times during the growing season. The tomatoes are packed from mature green to pink (stage 1 to 4).

The other is an organic grower that grows about 150 ac. of various cherry, Roma, and heirlooms. These are mostly indeterminate staked tomatoes and are harvested about 20 times during the growing season. The tomatoes are picked, packed and sold at around stage 4 (pinks) and riper.

D. CERTIFIED PRODUCERS AND CERTIFIED FARMERS' MARKETS

In Stockton, we visited one certified farmer and visited one certified farmers' market. The CA regulations allow the farmers to directly sell fresh fruits and vegetables to the consumer, and it exempts these certified farmers from certain size, standard pack, container, or labeling requirements for commercial producers.

The certified producer that we visited grows a large verity of vegetables including tomatoes and peppers on his 64 ac. truck farm. He grows about two ac. of various types of round and cherry tomatoes. We inspected several rows of 'early girls' that were grown nonstaked. These tomatoes were under regulations of the just-ended oriental fruit fly outbreak in Stockton. The farmer was not in the core area and was allowed to field treat these tomatoes for sale at the farmers' market.

We visited a certified farmers' market in Stockton. Here were about 20 or more certified farmers or their agents selling fresh fruits and vegetables produced on their farms. Others sold products that were processed from the fresh products such as pies, jams and dried nuts.

To be a certifier producer, the farmer must provide the County Agricultural Commissioner where he grows his products:

- The commodities/variety that he plans to grow for sale
- For each the acreage, harvest season, and est. production
- The location of the production site(s)
- Counties where he plans to sell at a certified market

The Agricultural Commissioner issues a certificate to the farmer. The production sites and the farmers' markets are subject to inspection, and a copy of the certificate must accompany the fresh products during transport and are posted at the point of sale. Certified producers are subject to fines up to $1000 for violations of this regulation.

During July 2012 Eric Jang and Charles E. Miller observed a cross-section of the fresh tomato production industry in CA. This included visiting four packinghouses and four farms from the Sacramento area in the north to the Fresno area in the south. Two of the packinghouses were on the farms. We also had a) an informal meeting with San Joaquin's County Ag Commissioner Scott Hudson, b) met with Spencer Walse, ARS in Parlier, c) visited a certified farmers market, and d) on Thursday afternoon the group met at the CDFA office with other CDFA staff including Bob Dowell, Debbie Tanouye, and Kevin Hoffman. On Friday, Charles E. Miller visited the same CDFA office to obtain data from past Medfly outbreaks with the help of Jason Leathers.

E. Chronology of Tomato Production and Postharvest Review – CA – July 16 to 19, 2012

Monday, July 16 - Large commercial producers

- Pacific triple E - Packinghouse, Tracy, CA - Abe Vargas
- Di Mare Fresh - Packinghouse, Newman, CA - Jeff Dolan
- Pacific Triple E - Field visit, Merced, CA - Steve McCann

Tuesday, July 17

- Abe El Produce – Orosi, CA - Franklin Abe - A small stake tomato grower, packs all stages from green to pink
- ARS Station, Parlier, CA, Dr. Spencer Walse

Wednesday, July 18

- Durst Organic Inc., - Esparto, CA – James Durst – Grows organic cherry tomatoes, Roma and heirloom tomatoes, mostly riper
- San Joaquin's County Ag Commissioner – Stockton, CA - Scott Hudson, County Ag commissioner

Thursday, July 19

- M&L Farms – Stockton, CA - Miguel Campuzano – Certified producer, grows variety of tomatoes, pick ripe, and sells at certified farmers' markets
- A certified farmers market - Stockton, CA

CDFA-APHIS – Sacramento, CA – The review team met with Bob Dowell, Debbie Tanouye, Kevin Hoffman, and others