WASHINGTON STATE UNIVERSITY
TRI-CITIES

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Subject: Malathion: Labeling and Use Information

I am responding to your request for information regarding malathion that was made to the Western Integrated Pest Management (IPM) Center. My response provides information pertaining to the questions regarding malathion labeling and use put forth by Cheminova. This response covers malathion use in Alaska, California, Idaho, Montana, Oregon, Utah, and Washington.

Alfalfa/Clover: Steve Norberg, Regional Forage Specialist with Washington State University provided the following information:

> Malathion has a place in the production of minor crops like clover. It is needed for resistance management in these crops because many times there isn't a broad selection of alternative chemistries. Control choices are limited in minor crops because most registrants don't find it worthwhile to register new chemistries on minor crops. Thus retaining malathion use on minor crops like clover provides growers an important treatment option. While malathion is not used on a regular basis in clover it would be unfortunate to lose this use. The primary use in clover would be for aphid control.
>
> Because it is a larger crop there are other chemicals labeled for use in alfalfa. Although there are other chemistries that growers would select first for pest control, malathion does have a place in alfalfa production for resistance management.

Barley: Phil Kaspari with the University of Alaska Fairbanks indicated that malathion is used in commercial barley production in the Delta Junction area of Alaska. It is used as part of their resistance management program, in rotation with other insecticides. For this use the current rates are adequate for pest control.

Berry: See attached completed questionnaires from Mark Bolda, University of California, Brian Cieslar, Enfield Farms and Curt Maberry Farm, and Joe DeFrancesco, Oregon State University regarding malathion use on berries in these states. In addition Alan Schreiber, Director, Washington Blueberry Commission provided the following information:

> With recent labeling changes the blueberry industry was forced to use a relatively low rate of malathion. This proved to be too low to be effective. Just recently the industry received a Special Local Needs (SLN) registration providing for the use of malathion for the control of Spotted Wing Drosophila (SWD). The SLN provides for use at 2.5 pints/acre with a 2-day pre-harvest interval (PHI). It is expected that this will increase reliance on malathion in Washington. SWD has a high propensity to develop resistance so blueberry growers are rotating modes of action.
>
> Malathion use is important in blueberry production because of its efficacy, mode of action, PHI, and its more acceptable MRL. In conventional blueberries, almost every acre will receive at least one malathion treatment. Export blueberries are important and therefore MRLs are critical. Despite the large number of insecticides registered on berries, there are few that can be used due to issues with efficacy, PHIs, or MRL restrictions.

Cherry: See attached completed questionnaires from Dane Alston, Utah State University, and Jeff Olsen, Oregon State University regarding malathion use in these states.

Tim Smith of Washington State University provided the following information regarding the use of malathion on cherries in Washington:

> In the recent past malathion use on cherries had decreased significantly due to the use of GF-120 for cherry fruit fly (CFF) control. The introduction of SWD changed this situation around almost completely. GF-120 doesn't work well for SWD. Because ULV malathion formulations work very well for CFF, and moderately well for SWD, the use of malathion as an aerial ULV application is on an upswing. The 1-day PHI for ULV malathion is its greatest advantage, because harvest sometimes takes several days in multi-variety orchards. The rate used in ULV applications is 16 ounces per acre.
>
> Malathion is now rarely applied by ground equipment; the only use in Washington is the aerial application of the ULV formulations. EC formulations of malathion are not compatible with foliar applications of summer weight oils for the control of powdery mildew, common these past few years. EC formulations sprayed on trees that have had oil previously applied shed leaves excessively. WP formulations leave unacceptable spray residue on the fruit.

The major disadvantage regarding malathion is the MRL issues that it faces in many trade markets and many packing houses don't want the product used.

Malathion plays a role in resistance management, as it and diazinon are the only organophosphate materials sprayed on sweet cherries anymore, and there is a building over-use of nicotinoids.

Citrus: In general malathion is now used in California citrus at fairly low use rates. However, because of the occasional need for malathion to control soft scales, it is critical that the higher use rates for citrus be retained. Please see the attached document regarding malathion justification for California's citrus industry.

Clover Seed: In clover seed production malathion is used on an occasional basis for outbreaks of several weevil species, the omnivorous leaftier, clover seed midge, and a few worm species. Fields that end up having problems with these insects will be treated 1-2 times per season. There are very few insecticides registered for use in clover seed so maintaining a malathion registration is critical; it is very effective and it is needed for use in rotation for resistance management. The rate and number of applications currently allowed are sufficient for effective insect control in clover grown for seed. Continued use of malathion is critical to the clover seed industry. Growers would suffer greatly (economic loss due to reduced seed yields) if malathion were not available to them.

Corn: There is some malathion use in corn production for the control of seed corn maggot.

Onion: There is some malathion use in onion production for the control of seed corn maggot.

Mint: The following information was provided by Rocky Lundy, Executive Director of the Mint Industry Research Council:

The total annual U.S. mint acreage each year is approximately 110,000 acres. Of that approximately 12% or 13,200 acres are treated with malathion. This pesticide usage data is based upon recent surveys. The use of malathion is mostly confined to mid-west mint growing states (Indiana, Michigan, Wisconsin) where over 30% of mint acres are treated with malathion. Over 90% of all the malathion mint treatments in Midwest states are for adult mint flea beetle. The remaining 10% use is for aphid and grasshopper control in both Midwest and Farwest states (Idaho, Oregon, Washington).

Malathion is a very important and irreplaceable production tool in Midwest mint production. While it is primarily used to control adult mint flea beetle, malathion is also used for grasshopper control in years favorable to grasshopper outbreaks. Each of these insect pests alone can account for yield losses of up to 50% if left unchecked.

There are several alternatives to malathion that are registered for use on mint: Lannate (methomyl), Orthene (acephate), and Metasystox-R (oxydemeton methyl). Neither Orthene nor Metasystox control mint flea beetles. Orthene and Metasystox control

aphids but neither control grasshoppers. Lannate does not control aphids or grasshoppers.

One of malathion's unique use patterns in mint is for control of adult mint flea beetle. University researchers have demonstrated the optimum time to control this pest is in the adult stage. This peak occurs post-harvest in mint. Consequently, malathion treatments are made to crop stubble after the mint crop is harvested. Thus this use pattern does not contribute to malathion residues in the mint crop. Even though the great majority of treatments are post-harvest, the malathion label has 7 day PHI. This leaves malathion as the only available control mint growers have if late season outbreaks of aphids or grasshoppers occur. The short residual activity of malathion and its low impact on beneficial predators and parasitoids enables mint growers to use malathion in IPM programs. For these reasons and others, the use of malathion is very important in mint IPM programs.

The U.S. mint industry is the world's leading producer of both peppermint and spearmint oil. U.S production accounts for 70% of the world's mint oil production. Over the last several years the United States has continued to lose world markets due to foreign competition. The loss of malathion in mint would be economically devastating to the U.S. mint industry and would give foreign competition further economic advantage.

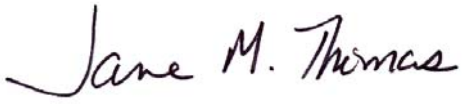
Pasture/Rangeland: In the past malathion was used for grasshopper control but that use has largely disappeared. One respondent commented that applicators found malathion did not have residual effectiveness and had to be reapplied frequently to provide good control. Another commenter stated that malathion has a minor role in insect control in pasture and range situations and he estimated that it was probably used on less than 1% of these acres on an annual basis. Malathion remains an alternative to more effective and newer insecticides for grasshopper and blackgrass bug control and provides some resistance management options by keeping products with different modes of action registered. For this purpose current labeling is adequate. One consideration for the use of malathion is that it is not a restricted use pesticide. If it were to become a RUP, then it would lose some of its usefulness. The 0-day PHI also plays an important part in malathion remaining as a useful alternative.

Watermelon: There is little malathion use in watermelon production in Oregon.

Wheat: Malathion is rarely used in wheat production. Typically dimethoate is used when there are heavy infestations of cereal leaf beetle or aphids. Malathion might be used if, for some reason, dimethoate were not available.

I hope you find this information useful. Attached as a separate file please find a spreadsheet showing malathion use in California for 2009 and 2010, the most recent data available from California's Pesticide Use Reporting System. I am also including a contact sheet should you wish to follow up with anyone who supplied me with information.

Sincerely,



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Malathion: Request for Use, Usage Information, and Benefits Information

Response from Mark Bolda, UC Farm Advisor, Salinas-Watsonville

Berries - California

1. **Labels**
    a. Are current label rates sufficient to meet the needs of growers? **Yes.**
    b. If not, what label adjustments would be needed to fully meet the needs of growers?

2. **IPM and Resistance Management**
    a. How might malathion be important as a resistance management tool? **As a rotation with other pesticides. Remember that in the small fruits, selection is limited and malathion is essential as an effective rotation partner.**
    b. What role can malathion play in an Integrated Pest Management (IPM) program?
    c. Do you consider malathion's short pre-harvest intervals and short reentry intervals to be important for any crops produced in your area? **Absolutely essential. Anything longer than 1 day PHI will not be used.**
    d. Are there any crop/pest combinations for which there are no/few suitable alternatives to malathion? **Raspberry/blackberry for spotted wing drosophila. The only other effective alternative is Mustang, and not having malathion as a rotation partner will move applications closer to 100% Mustang. Delegate is a good material, but not as effective generally as malathion and Mustang.**
    e. What other crop protection materials malathion is rotated with, and why (strengths/weaknesses in relation to other materials)? **Mustang, see above.**

3. **Potential Uses of Malathion**
    a. What are the major crop/pest combinations for which malathion may be used in your area? **Raspberry/ blackberry spotted wing drosophila, strawberry lygus bugs, whiteflies, aphids and vinegar flies.**
    b. What uses of malathion are considered to be critical and why? **Absolutely critical as an insecticide in caneberries, of importance in strawberry for management of vinegar flies and lygus bug nymphs.**
    c. What is the typical percent of crop treated with malathion each year for each crop/pest combination? **Area-wide, probably 100% of conventional caneberries are treated with malathion at least once, and at least 50% of conventionally grown strawberries.**
    d. Are there any state or local use limitations for malathion? **Not that I am aware of, although there have been some concerns over water quality.**

4. **For each of the important crop/pest combinations that malathion may be used, please provide the following:**

    a. What is the range of application rates used on each crop? **½ to full rate**
    b. What is the typical application rate defined as median? **Closer to ½ rate.**

c. What is the high typical application rate defined as 90th percentile? **Full.**
d. What are the considerations for determining use of a maximum application rate versus the lower rate? What frequency is the higher rate needed? **Good efficacy at ½ rate, and some maintenance of beneficials at the half rate. The higher rate is infrequently used, probably more often than not used for lygus p**opulations in strawberries.
e. What is the maximum number of applications per calendar year or crop cycle? **4 In some cases, multiple crops may be grown on the same location in the same calendar year. N/A in berries which are grown for the full year. It may be more relevant to report a rate per crop cycle for these situations. Certain other crops may take more than one calendar year to complete a crop cycle. Rates for these may also need to be reported per crop cycle. Details of the crop cycle should be described for crops that are not roughly aligned to a calendar year.**
f. What is the minimum and typical interval between applications? **At least two weeks, more often a month or longer.**
g. To the extent possible, please identify the application timing identified by time of year or season for each crop/pest combination. **Applications would take place starting in May for lygus in strawberries, and then from mid-July for vinegar flies in strawberries and spotted wing drosophila in caneberries.**

Malathion: Request for Use, Usage Information, and Benefits Information

Brian Cieslar, Agronomist, Enfield Farms and Curt Maberry Farm

Berries - Washington

1. **Labels**
   - **a.** Are current label rates sufficient to meet the needs of growers? **No. Not for blueberries.**
   - b. If not, what label adjustments would be needed to fully meet the needs of growers? **Rate should be returned to 2-2.5 pts per acre. 1.25 pts is inadequate for control of aphids and SWD**

2. **IPM and Resistance Management**
   - a. How might malathion be important as a resistance management tool?
   - b. What role can malathion play in an Integrated Pest Management (IPM) program?
   - c. Do you consider malathion's short pre-harvest intervals and short reentry intervals to be important for any crops produced in your area?
   - d. Are there any crop/pest combinations for which there are no/few suitable alternatives to malathion?
   - e. What other crop protection materials malathion is rotated with, and why (strengths/weaknesses in relation to other materials)?

   We use Malathion in rotation with zeta-cypermethrin (Mustang Max), imidacloprid, and thiamethoxam. The short pre-harvest interval interval makes it a very important part of our IPM program. It is quite effective on aphids and SWD, the main insect pests during harvest. We shy away from several other registered pesticides due to toxicity concerns, pre-harvest intervals, and MRL issues. Several pesticides were detected in exported blueberries in 2012 above the foreign MRL's. Such as methomyl and carbaryl, and there were others.

3. **Potential Uses of Malathion**
   - a. What are the major crop/pest combinations for which malathion may be used in your area?
   - b. What uses of malathion are considered to be critical and why?
   - c. What is the typical percent of crop treated with malathion each year for each crop/pest combination?
   - d. Are there any state or local use limitations for malathion?

   Blueberries and raspberries for aphids and SWD. We use Loveland Malathion 8 Aquamul due to competitive pricing, low odor, crop safety, tank mix compatibility. I'd say close to all of the raspberries and blueberries in Whatcom County are treated with Malathion 1-3 times each year. That's 7500 acres of raspberries and 3500+ acres of blueberries.

4. **For each of the important crop/pest combinations that malathion may be used, please provide the following:**

    a. What is the range of application rates used on each crop?
    b. What is the typical application rate defined as median?
    c. What is the high typical application rate defined as 90th percentile?
    d. What are the considerations for determining use of a maximum application rate versus the lower rate? What frequency is the higher rate needed?
    e. What is the maximum number of applications per calendar year or crop cycle? In some cases, multiple crops may be grown on the same location in the same calendar year. It may be more relevant to report a rate per crop cycle for these situations. Certain other crops may take more than one calendar year to complete a crop cycle. Rates for these may also need to be reported per crop cycle. Details of the crop cycle should be described for crops that are not roughly aligned to a calendar year.
    f. What is the minimum and typical interval between applications?
    g. To the extent possible, please identify the application timing identified by time of year or season for each crop/pest combination.

Raspberries 1-2 pts depending on timing. 1 pt preharvest in a tank mix with other insecticides. Blueberries 2 pts. Growers have used lower rates without success, and retreatment was necessary.

3-4 applications per year are necessary due to SWD infestations. Generally malathion is alternated with other products so would not be used more than every 2 weeks. Blueberries- we use malathion in late July thru September. Raspberries is more like mid July thru August.

Malathion: Request for Use, Usage Information, and Benefits Information

Joe DeFrancesco, Senior Faculty Research Assistant, Oregon State University

Berries - Oregon

1. **Labels**
    a. Are current label rates sufficient to meet the needs of growers?
    OK for caneberry and strawberry; Not sufficient for blueberry.
    b. If not, what label adjustments would be needed to fully meet the needs of growers?
    During EPA's recent review of OPs, the rate for malathion in blueberries was lowered to 1.25 lb ai/A. This rate may be sufficient for some insects in some situations but residual efficacy on the plants in the field is reduced at the lower rate, necessitating retreatment sooner than desired. This becomes evident when using malathion for control of spotted wing drosophila. Efficacy in controlling SWD is reduced to only about 25% after 7 days at the 1.25 lb ai rate. (A request for SLNs with increase application have been made recently.)

2. **IPM and Resistance Management**
    a. How might malathion be important as a resistance management tool?
    Malathion is an effective insecticide that has been used for many years without any indication of resistance. It is used in rotation with insecticides in different IRAC classes to reduce the likelihood of resistance.
    b. What role can malathion play in an Integrated Pest Management (IPM) program?
    Malathion is one of the safest OPs and works well in both cool and warm weather. It is highly effective and, when used judiciously, it can break the cycle of pest outbreaks.
    c. Do you consider malathion's short pre-harvest intervals and short reentry intervals to be important for any crops produced in your area?
    Berry crops have a long harvest season, with multiple harvests, and insecticide treatment is often needed in between harvests. The short PHI and REI in berry crops makes it extremely useful and another reason malathion is widely used.
    d. Are there any crop/pest combinations for which there are no/few suitable alternatives to malathion?
    Most pests found in berry crops have alternatives that are effective but not all of them can be used due to un-harmonized MRLs with Oregon's common trading partners.
    e. What other crop protection materials malathion is rotated with, and why (strengths/weaknesses in relation to other materials).
    A good example is for control of SWD. Malathion is rotated with spinosyns and pyrethroids. The short PHI and REI, and favorable MRLs are the main reasons.

3. **Potential Uses of Malathion**
    a. What are the major crop/pest combinations for which malathion may be used in your area?
    For blueberry, caneberry and strawberry: SWD and root weevil adults. It is also used for other pest.
    b. What uses of malathion are considered to be critical and why?
    See 3a, above. Effectiveness, short PHI and REI, and favorable MRLs make malathion critical for SWD and root weevils (both pests occur just prior to or during harvest).
    c. What is the typical percent of crop treated with malathion each year for each crop/pest combination?
    For blueberry and caneberry, almost <u>all</u> non-organic acreage has had at least one application of malathion applied in the past few years. Maybe only50% of the strawberry acreage is treated with malathion.
    d. Are there any state or local use limitations for malathion?
    No.

4. **For each of the important crop/pest combinations that malathion may be used, please provide the following:**

    a. What is the range of application rates used on each crop?
    Blueberry = 1.0 to 1.25 lb ai/A
    Caneberry = 1.25 to 2.0 lb ai/A
    Strawberry = 1.0 to 2.0 lb ai/A
    b. What is the typical application rate defined as median?
    Blueberry = 1.13 lb ai/A
    Caneberry = 2.25 lb ai/A
    Strawberry = 1.5 lb ai/A
    c. What is the high typical application rate defined as 90th percentile?
    d. What are the considerations for determining use of a maximum application rate versus the lower rate? **Rate influenced by how easily the insect is killed and residual efficacy needed. E.g. soft-bodied insects don't require a high rate but hard-bodied insects do. Insects with multiple generations per year require a higher rate so efficacy in the field last longer. What frequency is the higher rate needed? About 25-50% of the time, the higher rate is needed.**
    e. What is the maximum number of applications per calendar year or crop cycle?
    Two to three applications per year for berry crops. In some cases, multiple crops may be grown on the same location in the same calendar year. It may be more relevant to report a rate per crop cycle for these situations. Certain other crops may take more than one calendar year to complete a crop cycle. Rates for these may also need to be reported per crop cycle. Details of the crop cycle should be described for crops that are not roughly aligned to a calendar year.
    f. What is the minimum and typical interval between applications?
    Minimum = 14 days. Average is 21 days (when used in rotation with other insecticides, as is most common).

g. To the extent possible, please identify the application timing identified by time of year or season for each crop/pest combination.
SWD and root weevil = any time during June, July and August, early September.

Malathion: Request for Use, Usage Information, and Benefits Information

Response from Diane Alston, Entomologist and Professor, Utah State University

Sweet and Tart Cherries - Utah

1. **Labels**
    a. Are current label rates sufficient to meet the needs of growers?
    Yes

    b. If not, what label adjustments would be needed to fully meet the needs of growers?

2. **IPM and Resistance Management**
    a. How might malathion be important as a resistance management tool?
    Malathion is most frequently used in rotation with other insecticides with short REIs to protect cherries just before harvest. It is also used to control black cherry aphid and leafrollers in cherry.

    b. What role can malathion play in an Integrated Pest Management (IPM) program?
    As stated above, it is used in rotation with other insecticides near harvest. It is also an extremely helpful tool to manage spotted wing drosophila for those orchards in Utah infested with this new invasive insect.

    c. Do you consider malathion's short pre-harvest intervals and short reentry intervals to be important for any crops produced in your area?
    Yes! It is primarily used on sweet and tart cherry in Utah.

    d. Are there any crop/pest combinations for which there are no/few suitable alternatives to malathion?
    Leafrollers, black cherry aphid, spotted wing drosophila, cherry fruit fly: when rapid activity is needed and when there is a short window of time for management of these pests, malathion is a good fit.

    e. What other crop protection materials malathion is rotated with, and why (strengths/weaknesses in relation to other materials)?
    Strengths: short pre-harvest interval, relatively long-lasting, and softer (less toxic) than some insecticides (but most of higher toxicity insecticides have already been cancelled)
    Weaknesses: will flare spider mites by killing predatory mites (mite burn on tree foliage), and high cost

3. **Potential Uses of Malathion**
    a. What are the major crop/pest combinations for which malathion may be used in your area?

Sweet and tart cherry
Cherry fruit fly, black cherry aphid, leafrollers, and spotted wing drosophila

Some applications to peach for green peach aphid and perhaps peach twig borer (but other insecticides are primarily used for peach pests).

b. What uses of malathion are considered to be critical and why?
Cherry fruit fly: fruit near and at maturity is most susceptible to CFF and growers must harvest cherries, especially tarts, in a short time span, and so timing of CFF control and PHI intervals are of key importance. If a grower waits for a longer PHI, some crop is lost. Tart cherries are mechanically harvested. Once an orchard is deemed ready for harvest, usually the entire orchard is harvested within a matter of hours. Harvest equipment can run 24 hr per day during harvest, so PHIs and harvest timing is extremely critical – no room for error.

Leafrollers in cherry: Fruit-feeding and crop contamination with caterpillars near harvest is a major concern; the same issues as stated for CFF – PHI and harvest timings must be carefully timed.

Another advantage of malathion is that it has broader activity than many insecticides, so it can be purchased and used for aphids, CFF, leafrollers, etc. It gives the grower more flexibility to use this insecticide for multiple pests.

c. What is the typical percent of crop treated with malathion each year for each crop/pest combination?
Approximately 50% of tart cherries and 25% of sweet cherries right now. If spotted wing drosophila expands into primary fruit production regions of the state, the use of malathion could increase substantially.

d. Are there any state or local use limitations for malathion?
None that Diane Alston is aware of; Utah pesticide registrations and labels generally follow federal registrations.

4. **For each of the important crop/pest combinations that malathion may be used, please provide the following:**

a. What is the range of application rates used on each crop?
Follow the label.
b. What is the typical application rate defined as median?
c. What is the high typical application rate defined as 90th percentile?
d. What are the considerations for determining use of a maximum application rate versus the lower rate? What frequency is the higher rate needed?
e. What is the maximum number of applications per calendar year or crop cycle? In some cases, multiple crops may be grown on the same location in the same calendar year. It may be more relevant to report a rate per crop cycle for these

situations. Certain other crops may take more than one calendar year to complete a crop cycle. Rates for these may also need to be reported per crop cycle. Details of the crop cycle should be described for crops that are not roughly aligned to a calendar year.

1-2 times per season for sweet cherry
1-2 times per season for tart cherry
1-2 times per season for peach

f. What is the minimum and typical interval between applications?
7-10 days depending on weather conditions, time to harvest, and other factors

g. To the extent possible, please identify the application timing identified by time of year or season for each crop/pest combination.
Sweet cherry/black cherry aphid: petal fall
Tart cherry/cherry fruit fly: near harvest (mature fruit)
Tart cherry/leafroller: several weeks before harvest (mature fruit)
Sweet cherry and tart cherry/spotted wing drosophila: ripening fruit and near harvest (mature fruit)
Peach/green peach aphid: petal fall
Peach/peach twig borer: summer and near harvest (ripening and mature fruit)

Malathion: Request for Use, Usage Information, and Benefits Information

Jeff Olsen, Extension Horticulturist, Oregon State University

Cherries - Oregon

1. **Labels**
    a. Are current label rates sufficient to meet the needs of growers? **- yes**

2. **IPM and Resistance Management**
    a. How might malathion be important as a resistance management tool? **– it is one of the few organophosphates available so rotating malathion into a multiple spray program is helpful**
    b. What role can malathion play in an Integrated Pest Management (IPM) program? **– resistance management**
    c. Do you consider malathion's short pre-harvest intervals and short reentry intervals to be important for any crops produced in your area? **– yes, especially for Spotted Winged Drosophila (SWD)**
    d. Are there any crop/pest combinations for which there are no/few suitable alternatives to malathion? **– it plays a key role in SWD management**
    e. What other crop protection materials malathion is rotated with, and why (strengths/weaknesses in relation to other materials)? **For SWD it is a good rotation with Success.**

3. **Potential Uses of Malathion**
    a. What are the major crop/pest combinations for which malathion may be used in your area? **– SWD and cherry fruit fly**
    b. What uses of malathion are considered to be critical and why? **– SWD and cherry fruit fly. These are zero tolerance pests and a robust set of tools is essential in their management.**
    c. What is the typical percent of crop treated with malathion each year for each crop/pest combination? **– I would guess that about one quarter of the cherry crop is treated with malathion**
    d. Are there any state or local use limitations for malathion? **– not that I know of**

4. **For each of the important crop/pest combinations that malathion may be used, please provide the following:**

    a. What is the range of application rates used on each crop? **– cherries = labels vary**
    b. What is the typical application rate defined as median? **– don't know**
    c. What is the high typical application rate defined as 90th percentile? **– don't know**
    d. What are the considerations for determining use of a maximum application rate versus the lower rate? What frequency is the higher rate needed? **– resistance management would suggest the higher rates be used**

e. What is the maximum number of applications per calendar year or crop cycle? **In some cases, multiple crops may be grown on the same location in the same calendar year. It may be more relevant to report a rate per crop cycle for these situations. Certain other crops may take more than one calendar year to complete a crop cycle. Rates for these may also need to be reported per crop cycle. Details of the crop cycle should be described for crops that are not roughly aligned to a calendar year.**

f. What is the minimum and typical interval between applications? **– 7 to 10 days**

Summary of Malathion uses in California Citrus

Beth Grafton-Cardwell
Department of Entomology, University of California Riverside
Stationed at the Kearney Agricultural Center, 9240 S. Riverbend Ave., Parlier, CA 93648

March 13, 2008 (updated 2013)

While Malathion is used for miscellaneous insect pests (katydids, whiteflies, aphids) at fairly low use rates (1-2 lb AI/acre), it fills an important need for soft scale insects in certain situations. The use rates for these species (cottony cushion scale, citricola scale, and black scale) are 1-2 pts per 100 gallons and treatments for these pests are applied in 500-750 gpa. At these water volumes, the rate needed for scale insects is 5-15 lbs AI/acre (UC IPM citrus guidelines http://www.ipm.ucdavis.edu/PMG/r107301611.html). Rates lower than 5 lb/acre will not effectively control the scale species listed in Table 1 and efficacy is better with 7.5-10 lb/acre.

The alternative insecticides for these scale insects have a longer REI and PHI (methidathion), have more serious worker safety issues (methidathion), or are less effective against scales (carbaryl). The higher label rate should be retained for control of soft scales.

Table 2 shows that during 1997, when malathion was used for organophosphate-resistant California red scale, there were frequent applications of 7-15 lbs AI. Since that time, pyriproxyfen has become the primary California red scale control material, and the number of applications of 7-15 lbs per acre of malathion has declined. During 1998 and 1999, there were outbreaks of cottony cushion scale due to disruption of the natural enemies by pyriproxyfen. These outbreaks were controlled by malathion, thus malathion use for scales remained high during this period. Since 1999, the number of uses of 7-15 lbs AI/acre malathion have been quite low. However, one never knows when a scale pest upset will occur again and it is critical to maintain a label rate of malathion that will effectively kill scale insects.

Reasons for maintaining registration of higher rates of malathion:

1) Malathion use has declined, but that is because it is used less frequently for California red scale because of the registration of Esteem (pyriproxyfen) and Applaud (buprofezin) in 1998 (peak use of malathion in 1994-97 due to red scale resistance and multiple applications of OPs). It is still critically needed for secondary pests such as cottony cushion scale, black scale, and citricola scale.
2) Insect growth regulators, pyrethroids, and neonicotinoids are replacing OPs and carbamates for many citrus pests. However they do not control soft scales very well.
3) The alternative chemicals for soft scales are Supracide, which has a much longer REI and PHI and carbaryl, which is less effective than malathion for soft scale control. Assail is moderately effective against citricola scale. Lorsban is not very effective against cottony cushion scale.
4) Malathion has a relatively short (1 day) REI and (7 day) PHI and international MRLs are established. Growers need the flexibility of having a few insecticides that have short REIs so that they can make rapid pest control decisions without severely delaying harvest.
5) Malathion use was very high in 2010, but that was a low rate used for an exotic fruit fly pest eradication program. Note in Table 4 that the sum of lbs used was similar to the previous year, but the number of applications was much higher. This shows that many low rate applications were made. These reports exaggerate the actual acreage treated, since only portions of the orchards were treated.

Table 1. Summary of Malathion uses and alternatives for soft scales.

Malathion 8, REI 1 d, PHI 7 d, MRLs established

Pest	Rate form/acre	Water volume gpa	Rate AI/acre	Typical rate/acre	Typical timing	Low risk Worker Activities	Medium risk worker activities	Effective alternatives (REI)	Alternative REI	Alternative PHI	International MRL
Cottony cushion scale	1-2 pts/100 gal (1-2 lb/100 gal)	750-1500	7.5-15 lb	7.5 lb	May-July	Irrigation, scouting,	harvesting	methidathion Carbaryl	30 d 12 h	14 or 60 d 5 d	Yes Yes
Citricola scale	1-2 pts/100 gal (1-2 lb/100 gal)	500-1000	5-10 lb	5 lb	Aug-Nov	Irrigation, scouting,	harvesting	chlorpyrifos Assail	5 d 12 h	21-35 d 7 d	Yes, varies No
Black scale	1-2 pts/100 gal (1-2 lb/100 gal)	750-1500	7.5-15 lb	7.5 lb	Aug-Sep	Irrigation, scouting,	harvesting	chlorpyrifos methidathion Carbaryl	5 d 30 d 12 h	21-35 d 14 or 60d 5 d	Yes, variable Yes

Table 2 Number of applications of malathion in California citrus by lbs ai/acre for 1994-2006.

Rate (Lbs AI/Acre)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<1	883	206	70	21	20	119	476	150	189	918	334	224	437
1 - 2	9	9	15	11	6	28	10	20	14	3	8	12	48
2 - 3	11	3	2	16	8	12	5	13	5	2	5	7	14
3 - 4	2	0	0	9	7	2	4	5	3	5	6	10	2
4 - 5	3	2	1	11	5	12	2	9	1	6	0	0	5
5 - 6	2	1	0	8	6	4	4	2	3	0	2	5	8
6 - 7	0	2	4	32	5	3	5	3	1	5	1	5	9
7 - 8	7	4	6	22	14	28	12	10	11	12	18	6	5
8 - 9	2	14	91	45	11	31	2	10	8	12	6	4	10
9 - 10	1	1	3	49	10	36	1	5	7	18	0	5	17
10 - 11	0	6	5	18	24	39	1	10	6	1	1	5	11
11 - 12	18	2	5	13	22	31	4	6	7	3	0	3	2
12 - 13	3	2	1	140	22	26	0	11	4	2	3	16	5
13 - 14	5	1	0	11	11	10	0	1	1	0	0	0	0
14 - 15	3	1	3	5	3	7	1	1	0	0	0	0	0
>15	7	33	71	114	19	44	4	7	4	5	0	3	10

Table 3. Number of acres treated with malathion in California citrus by lbs ai/acre for 1994-2004.

Sum of Acres Treated with Malathion in California Citrus

Lbs ai/acre	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<1	6604.5	1104.4	512.5	431.6	692.8	2128.7	10189.0	4343.5	5205.8	15540.4	9082.0	6516.6	7815.7
1 - 2	127.3	89.5	79.3	169.3	179.0	694.7	103.0	472.8	387.8	57.0	88.3	238.5	774.5
2 - 3	213.3	8.8	17.0	182.0	155.0	380.0	55.0	139.5	97.0	21.0	21.5	132.3	172.6
3 - 4	20.0	0.0	0.0	255.0	284.5	31.0	57.0	451.0	76.0	20.5	263.9	495.0	40.2
4 - 5	260.0	88.0	64.0	246.0	32.3	111.2	6.0	168.0	14.0	28.0	0.0	0.0	51.0
5 - 6	80.5	15.0	0.0	100.0	91.0	44.0	22.0	26.0	33.0	0.0	25.0	46.0	237.0
6 - 7	0.0	5.3	48.3	416.0	141.0	84.5	26.0	55.0	2.5	93.0	20.0	254.8	264.0
7 - 8	121.8	97.0	145.0	296.0	216.0	684.0	151.0	606.0	133.0	132.2	728.0	79.9	256.5
8 - 9	30.0	225.9	2428.7	868.0	191.0	1160.3	78.0	163.0	183.6	206.0	107.0	31.0	238.5
9 - 10	10.0	40.0	42.0	745.0	152.0	1247.4	6.0	159.5	206.0	419.0	0.0	140	1329.4
10 - 11	0.0	49.0	31.0	227.0	709.4	1081.4	8.0	233.0	222.0	80.0	9.0	58.9	902.0
11 - 12	560.7	45.5	65.5	320.0	675.5	632.0	281.0	153.0	78.0	390.0	0.0	16.0	0.0
12 - 13	32.7	121.0	9.0	3862.0	239.0	481.5	0.0	304.0	58.0	15.0	160.0	491.0	81.0
13 - 14	49.0	20.0	0.0	182.0	240.5	196.0	0.0	23.0	5.0	0.0	0.0	0.0	0.0
14 - 15	50.0	20.0	91.1	34.0	69.0	87.0	6.0	10.0	0.0	0.0	0.0	0	0
>15	49.0	596.9	2012.6	2430.0	336.0	844.8	72.0	141.5	231.0	54.7	0.0	92.3	53.3

Table 4.

malathion				
	Year	SumOfAreaTreated	SumOfNumApps	SumOfLbsChemUsed
	1991	384.00	29	597.82
	1992	1091.20	39	4811.21
	1993	781.25	56	5666.82
	1994	1249.16	45	10066.52
	1995	1382.42	72	15144.30
	1996	4729.08	184	53188.22
	1997	10263.00	481	123958.62
	1998	3648.66	151	31703.13
	1999	7583.79	301	71496.83
	2000	5684.00	208	6240.36
	2001	6860.30	237	19558.70
	2002	5820.90	201	11662.78
	2003	9895.78	328	16099.46
	2004	10205.49	334	12529.23
	2005	8221.80	279	18100.78
	2006	11516.70	483	34471.54
	2007	11641.55	455	55210.44
	2008	5275.60	236	20588.47
	2009	5904.44	248	19864.33
	2010	122799.90	1557	20748.15

Malathion: Labeling and Uses
Contact List

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