LINWOOD SUPPLY, INC.

The Light Brown Apple Moth or LBAM

Epiphyas postvittana; Tortricidae; Lepidoptera.

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By now everyone in the agricultural and horticultural industries is well aware of the newest insect pest in California. The Light Brown Apple Moth (LBAM) is native to Australia and has recently arrived in California. LBAM has been found at many of the inhabited areas of our state and in many nurseries, landscapes, golf courses and agricultural crops. Besides Australia and California it is present in New Zealand, Britain and Hawaii. The big question is not "H*ow did it get here*?" or even "*why*?", but instead we need to ask: "*How can we control it now that it has us*?"

The first thing to do is to learn about this pest and find its weaknesses. Even though LBAM has been a serious pest elsewhere and has been well studied and documented, California has many climates and environmental conditions which may allow the insect to adapt and express itself in unexpected ways. The Light Brown Apple Moth (LBAM) is a lepidopterous (caterpillar) insect that in the larval stages of its growth feeds as a leaf roller/caterpillar before pupating into the adult (breeding) form. Most often by the time you see the caterpillars or find the damage it is too late, at least economically, to try the soft controls.

The eggs are laid in masses and in 5 to 7 days hatch; the larvae emerge as caterpillars then migrate to the underside of the leaf and begin to feed. The LBAM is a Tortricid or tortrix caterpillar. Tortricid refers to the insect family *Tortricidae*, which includes the leaf rolling caterpillars. Tortrix means "to twist"; when used by entomologists it is simply a Latin word used to mean "Leaf Roller". The young caterpillars begin to produce silk which they use to protect themselves by forming an insulating shelter. With each successive instar they produce more silk and by the second or third instar begin to "roll" leaves to create a protected feeding shelter. After five to seven instars they pupate. Prior to pupating, the larvae roll the leaf blade lengthways over themselves, gluing it down with silk for protection from wind, rain, and predators. Sometimes they will glue two leaves together for the same effect. The rolled leaf also functions very well as a protective "tarp", shielding them from non systemic insecticides.

Typically LBAM will complete three and in sometimes four generations, with the second generation being the most damaging in economic terms. In some areas the generations overlap, resulting in all life stages being present at the same time. The larvae can over-winter by locating mummified fruit or vegetation on the ground or by rolling leaf shelters on alternate host plants. During the winter the larvae can survive at least months without feeding. During the later larval stages the caterpillars will feed voraciously, often between two leaves webbed together. In ornamentals, the damage is limited to foliage; in agriculture, feeding damage also affects the fruit and includes orchards, berries and grapes. Over 250 host species have been reported including all fruit crops, greenhouse crops, vegetables, ornamentals, native plants, citrus and even young conifers. The early instars may feed beneath the upper epidermis of the leaf, in this regard the early instar is somewhat similar to a leaf miner; the older instars feed on the surface of the leaf consuming all tissue except for main veins. The early instars have a dark brown head and are about 1.6 mm long; the final instar is about 15 mm long with a light brown head. The time from larvae emergence to pupation takes about 450 degree days, typically a term of about 6 - 8 weeks.

Pupation takes place inside the final feeding shelter. The pupa is soft and green initially, hardening and turning brown as they age. The insect will remain in the pupae stage for 132 degree days or about 1 to 4 weeks in most areas of California. The adult moths emerge and mate soon after emerging. The females deposit their eggs at night, in masses of 20 to 150 eggs per cluster. The adult lifespan is about 30 days after emergence. The adult is about 10 mm long and when at rest forms a "bell" shape. The adults are most active 2-3 hours after sundown (dusk) and again 3-4 hours after sunrise. Interestingly, the adult moths' peak flight activity occurs around a new moon and during the full moon. *A chart is included on the last page of this bulletin showing the dates of the full and new moon through December of 2008, and includes the time of sunrise and sunset for the Sacramento Valley. The times at other west coast locations will change slightly due to the differences of longitude and latitude.*

This life cycle information provides us with the ability to take advantage of peak activities and vulnerabilities, including the knowledge that larval stages can be controlled with a variety of contact and ingested chemical sprays. The larvae are easier to control during the early instars before they roll up and a systemic pesticide will be more effective on the later larval instars. The best time to use pheromones and lures to monitor or disrupt mating cycles is during the full and new phases of the moon and shortly after sunrise and after sunset; because the adults do not actively feed, contact chemicals and oils will be the best choice to control the moths. The phases of the moon are also useful in timing the release of predators, especially the *Trichogramma* wasp. Both adults and the eggs are vulnerable to oils. The larvae can over-winter in weeds or other nearby plants including crops, landscaped areas and native vegetation.

Integrated Pest Management (IPM) involves using all of your tools in the most effective manner while choosing the best course of action that will have least impact on the environment. But in fact, we also need to balance these choices with the economic impacts we are faced with while trying to bring a crop to market. If we choose to allow nature to take its full natural course, the financial losses may be devastating. The point at which a problem begins to cause a financial loss is known as the economic threshold. For most growers, LBAM will present them with a sudden and devastating economic loss threshold. Because of the economic impact LBAM represents, growers may need to use the chemical products as a first defense to preserve their crop. As part of your Integrated Pest Management Program, we recommend chemical applications when the LBAM caterpillar or moth is first found on a nursery or landscape. Monitor using lures and traps around the full and new moon. Do not use the same chemical more than twice in succession. This will allow you maximum protection from this pest. As the LBAM population is eliminated, declines, or at least becomes controllable, switch from chemicals to more eco-friendly methods. Because the use of chemical insecticides can (will) also kill beneficial insects, you should at least consider establishing colonies of beneficial insects. For the second year (or in between generations) reverse the procedure and start with the non-chemical controls. Use the insecticides only when an outbreak occurs but before economic threshold is reached, or if required by local authorities. The over-wintering population can be estimated by inspecting evergreen broadleaf plants, mummified fruits, and winter weeds for the presence of larvae. If over-wintering larvae are readily found then an early spring chemical application will be warranted and a dormant spray should be considered. The host plants, weeds and plant debris should be eradicated and removed if at all possible.

Chemical Controls. Few if any pesticides registered in California list the "Light Brown Apple Moth" by name, but several do list "Leaf Rollers". You may need a written recommendation from a pest control advisor to use these products and some products should only be applied by licensed Pesticide Applicators. Some products are toxic to bees and require a notice of intent (NOI) for that reason. Some of the technical literature and research indicates chemical controls, when applied for the more common insect pests have at least limited activity on LBAM. Before you spray for LBAM, scout to see if the insecticide you just sprayed for aphids or thrips had any "beneficial" side effects; you may be able to postpone a planned insecticide application or switch to a "softer" control. Insecticides which are expected to be effective against the Light Brown Apple Moth and are registered for "leaf rollers" include the following:

Chlopyrifos currently manufactured by Quali-Pro. This organophosphate is highly effective against chewing insects such as LBAM. CDFA and other government agencies have suggested this as a preferred insecticide. Chlopyrifos has a Warning Label, and is a restricted chemical requiring a permit for use. It degrades by phosphate cleavage, microbial activity and UV light. Also registered for use against ants, beetles, whitefly, mites, borers and black vine weevils, aphids, scale, adelgids, and many others.

Acephate is an organophosphate and is locally systemic in the leaves. This means that it only enters into the cells close to where it is deposited on a leaf. A true systemic would travel throughout the plant tissues. Acephate tends to stay close to where it is deposited so thorough coverage is essential. Most formulations have an objectionable odor so do not use this product near residential or similar urban areas. This chemical is a cholinesterase inhibitor and works by disrupting nerve impulses. Labeled to control leaf rollers, Acephate is an excellent choice for LBAM as it has a Caution label and is relatively inexpensive. Also registered for use against fire ants, beetles, whitefly, black vine weevils, and thrips, among others

Bifenthrin is a third generation pyrethroid (synthetic pyrethrin) which acts on the insect's nervous system by disrupting the nerve cell ending and also by inhibiting the production of the ATP enzyme. This is a restricted product registered requiring a permit for use. Besides leaf rollers it is also labeled as a drench to control Black Vine and Diaprades weevils, Fungus gnats and white grubs.

Carbaryl is a carbamate, is registered for use against leaf rollers in ornamentals, and has a Warning label. The use of Carbaryl can stimulate spider mites and this product should never be mixed with oils. Toxic to bees Carbaryl will require a notice of intent before spraying. This is a very safe product in terms of human toxicity; it is used extensively by homeowners as flea powder for pets. Carbaryl will also control ants, aphids, leafhoppers, loopers, psyllids, scale, beetles, plus many others.

Pyrellin. Contains both Pyrethrins and Rotenone with a very broad label. Pyrellin is a botanically derived insecticide which may be combined with other insecticides. Pyrellin EC has a Caution label. Also registered for use against leaf miners, whitefly, black vine weevils, aphids, thrips, mites and others.

Cyfluthrin is a synthetic pyrethrin, at least one version is labeled for leaf feeding caterpillars and has a Caution label. This product provides a rapid "knockdown" and a broad label which includes Fungus gnats, aphids, mealybugs, psyllids, scale, thrips, whiteflys, and also fleas, ticks, spiders, crickets and cockroaches.

Methomyl is a fast acting ovicide, larvicide and adulticide intended for use on agricultural crops. This carbamate product has a Danger label and a fairly short term residual action with a fast knockdown. It functions primarily as a contact insecticide and is manufactured by DuPont under the trade name 'Lannate'.

Oils: Horticultural oils were first developed by Dr. Volck in the early 1900's and are still used extensively. Oils are very effective in controlling most species of insects including LBAM larvae, adults and eggs. To prevent leaf burn (phytotoxicity) during the summer months the oils selected should be classified as "light" summer oil. In colder months these can be safely applied as a dormant oil to kill over-wintering larvae. Be aware that oils are a contact insecticide which will also kill all beneficial insects.

Non Chemical Controls.

Azadirachtin is a secondary metabolite present in Neem oil. It is a contact insecticide, known to control over 200 species of insects, including aphis, scale, whitefly, caterpillars (including leaf rollers), leafhoppers, thrips, mites, by acting mainly as a feeding inhibitor and growth disruptor. It fulfils many of the criteria needed for a natural insecticide; it is biodegradable and has a very low mammalian toxicity.

Spinosyan is derived from a naturally occurring soil borne fungi *(Actinomycete Saccharopolyspora Spinosa)*. Also known as spinosad, this product has a caution label, and is a good choice for alternating with chemical insecticides. Spinosad kills susceptible species by causing rapid excitation of the nervous system but must be ingested by the insect. Effective on the LBAM larvae and other caterpillars, it has little effect on the moth (adults), on sucking insects or non-target predatory insects. Insects exhibit symptoms within minutes resulting in rapid cessation of plant damage with death occurring about 1 to 2 days. Manufactured by Dow Agro-Sciences and sold as 'Conserve', other tradenames are registered for agricultural use. Other pests controlled include thrips, leafminers, mites, beetles and fleas. There is a limited label for Chemigation of field grown bulbs.

BT Bacillus Thurengensis. This is a pathenogenic bacterial derived insecticide. BT is not very effective as a control, but works well when applied as a preventative, on a regular basis, before the LBAM appears on your nursery. BT is only effective on Lepidoptera insects and must be ingested; after ingestion the bacteria grow inside the caterpillar causing death after several days.

Predators and Parasitic wasps. *Trichogramma* wasps lay their eggs inside the LBAM eggs; the parasitic larvae consume the LBAM larvae prior to hatching. Other predators include earwigs and spiders.

Essential oils. These products are typically derived from aromatic, herbal and vegetable oils. Similar to the petroleum-based horticultural oils these products control the insect by suffocation and chemical burning. During hot, dry weather leaf burn is a potential hazard; best to apply these in early morning or late evening - which is also when the adults are most active. These products do not require the stringent protocols and regulation of the traditional chemical products so be sure to read the label and MSDS carefully for the brand you plan to use. These oils will kill all beneficial insects as well.

Blue Light and UV light Traps. The good old fashioned "Bug Zapper". It is doubtful this method will ever provide a high degree of effectiveness but it could account for a good percentage of the adults on selected nights. Use an irrigation timer to turn the light on automatically during the night and off in the morning. A semi-permanent trap using blue light and sticky traps is also available from Linwood Supply.

Pheromones and Lures. These products are used to disrupt the mating of the adults, as lures for trapping and monitoring the insect population. Many are versions available.

Chelated Metals. Metals simply taste bad; some form natural compounds inside the plant that will repel many chewing insects. Try using chelates of copper, iron, manganese; these are fertilizers, not pesticides and do not require reporting. Be careful about over-applying, do not allow runoff and avoid using near any water such as ponds or creeks. *Does your crop need these essential nutrients anyway?*

Ancient knowledge. Except naturally occurring predators and microbes these "old timers" predate all of the previously discussed controls and are still effective today offering a very broad spectrum of uses. You must discuss with your local Ag Commissioner as to whether these are considered to be pesticides, fertilizers or a "grey area"; opinions often vary between counties. Other government agencies also need to be consulted, such as local storm water authorities, especially concerning materials containing copper; all forms of copper are toxic to aquatic organisms. *Your stated intention will probably be the defining factor in how the status of the products from this group and of similar products is interpreted.*

Lime Dust and Lime Sulfur spray. The use of lime and lime sulfur for pest control is still used in modern agriculture, particularly on tomatoes prior to harvest. The disadvantage is a white chalky residue is left on the foliage. If your crop is young and not yet saleable this may be a good option. The lime desiccates the caterpillars and eggs and also shields the leaf surface from feeding. When washed onto the soil this alkali material can raise a soil pH and provides calcium, an essential nutrient. Be careful of leaf burn, if in eyes flush with plenty of water. *Check with your Ag Commissioner as to the status of this product.*

Sulfur Dust. Similar to lime dust; the difference between being an essential nutrient and a pesticide is blurred. Sulfur can function as a poor man's fungicide. Sulfur will form sulfuric acid when washed onto a soil which will lower your soil pH. Be careful of leaf burn, if in eyes flush with plenty of water. *Check with your Ag Commissioner as to the status of this product*.

Copper Sulfate. Besides repelling insects and being a required micronutrient, copper sulfate has strong fungicidal and biocide properties and has been used to control fireblight. Copper functions in process of photosynthesis. Copper is toxic to aquatic organisms, keep away from all storm drains and any body of water. *Check with your Ag Commissioner as to the status of this product; many of these brands are labeled as pesticides and have an EPA number, others are labeled as fertilizers.*

Bordeaux mix: first discovered about 1860, this was a very effective and perhaps the first "manufactured" pesticide; it was still very widely used into the 1980's and continues to be utilized today. Initially Bordeaux mix was created to repel people who otherwise would steal grapes; the farmers quickly discovered it also was effective against powdery mildew and repels insects. It will also control or suppress bacterial diseases such as fireblight and oleander gall. The mixture is made from powdered copper sulfate and lime powder. Be careful of leaf burn, if in eyes flush with plenty of water. *Check with your Ag Commissioner as to the status of this product*.

Cultural controls.

If you have not already done this, get the place cleaned up. Use Glyphosate to kill existing weeds; you can either tank mix with or follow up with a good pre-emergence herbicide. Weeds adjacent to your nursery, between the beds or in the cans represent vast reservoirs of insect pests, plant many diseases, and provide a seed bank for future weeds. Many a grower has spent a fortune spraying a nursery or greenhouse while ignoring the perimeter defenses and have the insects return in full force in just a few days. This one of the best examples of utilizing the principles of Integrated Pest Management - control the pests by controlling the weeds. Eliminating weeds will also remove "habitat" for mice and rats. After eradicating the existing weeds, apply a pre-emergence herbicide, such as Oryzalin, to the soil. Oryzalin can be applied directly over (most) outdoor container plants to keep weeds from germinating both on the ground and in the containers. Herbicides are very effective IPM insect and pest controls.

For many years farmers in California have sprayed pesticides at night. The advantages include: cooler working temperatures for the applicator, less chance of random human intrusion or exposing employees to drift, typically a lower chance of inversion layers forming, and less chance of phytotoxicity (burning). Another advantage is at night, a slower drying time of the pesticide allows for greater exposure to the insect. Honeybees are not active at night and this is an advantage when using insecticides that are harmful to pollinators. Consider that on certain nights (*see chart*) the adult moth will be more active during a new or full moon. If you can do so at your site, nighttime spray operations may be a viable option.

Never use the same or similar chemistry on a given pest or crop more than once or twice in succession; alternate different chemistries as often as is practical to avoid developing resistant insect populations. Often growers will select and over use chemistries based on lowest cost or use similar chemistries with identical modes of action, like the pyrethrins/pyrethroids, too frequently. The result is that chemicals will loose effectiveness as the insect population adapts and become genetically resistant to a specific chemical, or worse, cross-resistant to an entire class of products. If an insect population develops resistance the tools needed to maintain an effective IPM program are greatly diminished. The use of harsher chemistries, less effective and perhaps more expensive controls, higher rates, and more frequent sprays will be the result.

Plant an insectary herbarium to foster populations of beneficial insects. Some nurseries use show gardens for this purpose. Select plants that will provide an environment where the beneficial insects (predators) can thrive, then release colonies of purchased predators; as you get your noxious pests under control, these predators will move into the nursery to help maintain a balanced ecosystem. If you need to spray, go ahead, but then restock these areas with beneficial insects as needed. Be careful concerning pesticide toxicity to pollinators such as honeybees. *Consider offering to place beneficial insects in an adjacent neighbor's landscape at no charge - this will provide you with a "free" insectary and a friendly neighbor.*

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Sources of information used to prepare this Product Bulletin include:

- California Dept of Food and Agriculture, CDFA. Website and literature.
- Australian ministry of Agriculture publications via internet June 2007.
- UC Davis websites, June 2007
- Cal Poly San Luis Obispo; IPM Conference 2007
- US Naval Observatory Website, 2007
- Insects, The Yearbook of Agriculture 1952, USDA
- 'Light Brown Apple Moth in Orchards' by David Williams, Victoria, Australia

For more information, please contact Linwood Supply, Inc. at 707 678-5087 or visit our website at: www.LinwoodSupply.com

Table 1.

Critical Dates for LBAM Control

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Jan through Dec 2008 Location: Sacramento, California

24 hour clock: NOT adjusted for daylight savings

source: US Naval observatory

date	Phase of	SUN		MOON	
	the Moon	Rises	Sets	Rises	Sets
2008					
1-8	New	07:24	17:01	07:52	17:19
1-22	Full	07:19	17:16	17:41	07:37
2-7	New	07:06	17:34	07:30	18:28
2-21	Full	06:50	17:50	18:47	07:04
3-7	New	06:28	18:06	06:22	18:29
3-21	Full	06:07	18:19	18:39	05:53
4-6	New	05:42	18:35	04:47	17:16
4-20	Full	05:22	18:48	19:34	05:08
5-3	New	05:06	19:00	03:38	17:18
5-18	Full	04:51	19:14	16:25	02:47
6-3	New	04:43	19:26	04:10	20:01
6-18	Full	04:41	19:33	20:06	04:17

	7-3	New	04:47	19:34	05:14	20:32
	7-18	Full	04:56	19:27	20:00	05:07
	8-1	New	05:08	19:16	05:21	19:38
	8-16	Full	05:21	18:58	18:58	05:05
	8-30	New	05:34	18:38	07:30	18:13
	9-15	Full	05:48	18:13	18:15	06:08
	9-29	New	06:00	17:51	06:26	17:47
	10-14	Full	05:47	18:15	17:10	06:08
	10-28	New	06:29	17:10	06:21	16:43
	11-13	Full	06:46	16:54	17:04	07:31
	11-27	New	07:01	16:46	07:18	16:32
	12-12	Full	07:15	16:45	16:46	07:30
end	12-27	New	07:23	16:52	07:46	17:04

Data for 2009 and 2010 will be available upon request in Decemeber of 2008