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The Pink Bollworm

Tale of a Transgenic Tool

Dr. Thomas Miller, UC Riverside, and Dr. Robert Staten, USDA-APHIS

The pink bollworm, *Pectinophora gossypiella,* was first described from larvae recovered from infested cotton bolls in India in 1843. It can spend the winter in cottonseeds in a state of suspended development called diapause. In this state, *P. gossypiella* was unwittingly distributed worldwide in cottonseed shipments. The first reported cotton infestation in North America occurred in 1911 in northeast Mexico, reportedly from infested Egyptian cottonseeds. The bollworm was shipped in cottonseeds from Mexico to Texas in 1917, moved overland from there to Arizona by 1927 and reached California in 1965. By 1969 the California legislature set up the Cotton Pest Control Board with powers to raise money from a bale tax assessment to pay for a sterile insect technique (SIT) program aimed at preventing the pink bollworm from becoming established in the Central Valley growing area. In SIT, large numbers of insects are reared, exposed to radiation that sterilizes them, then released daily in cotton-growing areas suspected of harboring adult pink bollworms migrating in from infested areas. The sterile insects mate with the native ones, producing no offspring. Over time, the ratio of sterile to normal insects increases, driving the native population to extinction.

The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) assists states in controlling this pest and preventing its spread to other states. APHIS enforces quarantine in infested areas, requiring certification for the interstate movement of regulated articles.

Recent History

The entomology department at the University of California at Riverside (UCR) has had a longtime interest in the biology of the pink bollworm. Harry Shorey led a team that identified the female sex pheromone, which improved the trapping of males for field population assessment. Hal Reynolds defined the cultural changes in cotton production needed to control pink bollworm. Today, Ring Cardé is studying the intimate behavioral response of the males to the sex pheromones.

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The authors began working together on the pink bollworm in 1984 when they perfected a pheromone trap for use in monitoring resistance to insecticides. Other UCR faculty borrowed this method, expanding and varying it for use against other pests including citrus thrips, leaf miners, and whiteflies.

While Bob Staten developed the pheromone confusion and other area-wide techniques used in conjunction with SIT, Tom Miller automated a Multipher® pheromone trap and determined that temperature and wind speed drastically influenced the nightly catch of males in pheromone traps. With Mohamed Salama, he then identified the diapause-associated protein from pink bollworm and perfected an antibody test for diapause in prepupal pink bollworm, which revolutionized the determination of diapause.

Could SIT (sterile insect technique) be improved by putting lethal genes into the pink bollworm?

The diapause project convinced Staten that we might possibly improve the SIT method by developing a genetic transformation system for putting a conditional lethal gene into the pink bollworm. At the time Staten made this suggestion, putting genes into the vinegar fly, *Drosophila melanogaster,* by using a "jumping gene" called a P-element was being discussed at academic gatherings as something that could be applied to other insects in the future.

The available literature in the late 1980s mentioned genetic control of insects, and a certain amount of funding had been invested in this approach to control mosquitoes. However, there were no working models to go by for something like pink bollworm, and compared to *Drosophila*, very little was known about the pink bollworm genome.

Humble Beginnings

From this inauspicious beginning, but with strong support from the Cotton Pest Control Board in California, we started the effort to improve SIT. Our colleague Karl Fryxell suggested trying a mutation of a common gene called *Notch* from the vinegar fly. *Notch* genes play key roles in developing the embryo. The *Notch* mutation allowed normal development at warm temperatures but prevented the egg from developing at cool temperatures. By rearing equal numbers of mutant *Notch* flies together with normal ones at cool temperatures, we caused a collapse of the whole population.

We adopted the term ABC (Autocidal Biological Control) to describe this use of a pest insect against itself. Four years later, Steve Thibault figured out how to put genes into pink bollworm, a small gene called the green fluorescent protein (GFP) gene became widely used as a marker, and a second lethal gene was shown by Luke Alphey at Oxford University in England to work in ABC.

Steve Thibault put the GFP marker gene into the pink bollworm in early 1998 and John Peloquin bred a pure strain at UCR by early 1999. John and Steve also were able to pull out the gene they inserted to show that it was actually attached to the pink bollworm chromosomes. From this point on, progress on this project was overwhelmingly dictated by the needs and constraints of the Plant Protection Act and National Environmental Policy Act regulatory requirements.

A website maintained by the USDA describes the current status of all permits requesting release of genetically modified (GM) organisms: **http://www.aphis.usda.gov/bbep/bp/**.

The Permitting Process

We initiated a permit application well before our transformation protocol was perfected. The original instructions urged permitees to begin the process early in anticipation of the transformation event. We did this, opening a dialog with the Biotech Permits office in Riverdale, Maryland.

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When the USDA began issuing permits to release transgenic organisms (or genetically modified organisms, GMOs), the first permit requests came from multinational companies intent on selling commercial seed varieties. Sometime between the first permit to release GM plants and the present time, the regulatory process stiffened and permits became more difficult to obtain. The new set of rules called for so much more work, we withdrew our original 1996 application.

The backlash has been particularly difficult for the Permits Branch of USDA-APHIS. They receive input from advocates and scientists in favor of biotechnology, environmentalists against biotechnology, government officials looking over their shoulders, and industry demanding action. All of these groups are well meaning in their intent.

Our transgenic strain marked with the GFP protein gene was not fully stable until late in 1998. At that time we requested a permit to move the transformed pink bollworm strain from Riverside to Phoenix, from one quarantine facility to another. This required some construction, including restricted entry rooms with outer and inner doors for security, which took time and funding. The USDA-APHIS permit No. 98-244-02m was issued on March 8, 1999.

Our application sat quietly with USDA while the GM food controversy left the front pages.

At the height of the media coverage over GM foods, we reapplied for a permit to do a field test of the fitness of the GM pink bollworm compared to a standard strain. The application sat quietly on the USDA website while the GM food controversy gradually left the front pages. At this point Scott Kilman of the *Wall Street Journal* found the pink bollworm application on the USDA website and decided to write a story about the new genetically modified insect. He conducted interviews and wrote his story last October, but had to wait three months until the furor over the contested U.S. presidential election quieted down. Kilman's story was finally printed on Friday, January 26, 2001.

Public Dialogue

As part of the process of applying for a permit to release transgenic pink bollworm, the USDA-APHIS Permits Branch solicited comments on the permit request from scientists inside and outside of the agency. The Permits Branch then asked us to answer all of the questions raised by respondents, which we did. Some of our replies were labeled as "unacceptable." Much later we were told that some of the questions were unanswerable.

One question, for example, asked where the gene was inserted in the pink bollworm genome. The simple answer was we don't know. By knowing the nucleotides in the inserted piece of DNA, and by identifying the bits of DNA that belong to the pink bollworm, we could ask the Gene Bank computer if the pink bollworm bits of DNA were related to any known genome. The computer gave back the answer that no known sequences were similar to the pink bollworm DNA we provided (**http://www.med.usf.edu/~yyao/Genebank98.html**).

Thus, the exact location of the inserted DNA within the pink bollworm DNA could not be determined without a great deal more work. Moreover, every time we try to put a new piece of foreign DNA into the pink bollworm, the genes insert in a unique place in the chromosome. This process is not completely random, but is governed by rules not yet understood. The effort expended to learn where the GFP marker was located in the pink bollworm DNA would not be applicable to the next time we make a strain that has the lethal genes included. Thus our modest research effort was delayed when it appeared that detailed information was required that could only come from a much higher investment in time, expertise, and money.

In truth, we could not understand what the details of the site of insertion had to do with the permit process.

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It did not reveal anything that would be of any value in predicting the behavior of the transgenes when released with pink bollworm. Besides, risk should be based on the phenotype or introduced traits, not genetic structuring.

"Jumping" Genes and "Junk" DNA

Two articles in the November 10, 2000 issue of *Science* magazine (Vol. 290, Issue 5494) addressed gene duplication. In "The Evolutionary Fate and Consequences of Duplicate Genes" by Michael Lynch and John S. Conery, on pages 1151-1155, strong evidence was presented to suggest that genes copy themselves often. On pages 1065-1066, Elizabeth Pennisi's "Twinned Genes Live Life in the Fast Lane" favorably critiques Lynch and Conery's work, pointing out that not only are genes copied far more frequently than researchers previously had thought, but that the duplicates are lost from the genome far faster. This work suggests that some duplicate genes play a key role in the evolution of new traits and creation of new species. Lynch and Conery were able to find the age of the copy events they studied as measured by the number of mutations, silent and functional, all of which supported the suggestion that gene duplication furthers evolution.

The DNA got there by unorthodox means, but it was inserted by natural mechanisms.

This shows that the presence of "junk" DNA in genomes is common whether the source is random insertion of "jumping genes," DNA-inserting viruses, duplications, or other types of "mistakes" made during ordinary cell division, and that these events are a natural part of evolution. "Junk" DNA is defined as extra DNA not necessary for cells to function in an organism. It is now suspected that a great deal of the DNA in our bodies is, by this definition, junk DNA.

Since we inserted a bit of DNA into pink bollworm, it means the element got there by an unorthodox means, but it was inserted by natural mechanisms. The native DNA dictated where it would go, not us. It is subject now to the whims of genetic selection, just like all the other junk DNA. If it confers a selective disadvantage, successive generations will purge it from the genome or relegate it to a sort of immortality in an inactive form.

The DNA we are inserting into pink bollworm at the moment is the marker gene called GFP plus another piece of DNA called a promoter that activates the marker gene. If we inserted a toxin gene, or perhaps a gene that confers resistance to herbicides, or a gene product that might cause an allergic reaction, we might arguably have something representing a potential risk for unwanted outcomes (e.g., pollen from Bt corn landing on milkweed and posing a threat to Monarch butterfly caterpillars; herbicide resistance genes getting into weeds; GM corn winding up in tacos).

GFP is not going to be released as pollen, nor confer a resistance trait, nor cause an allergic reaction in any animal, especially human beings. The genetically altered pink bollworm can fly, but it is not nearly as invasive, nor as capable of movement as pollen (identifying pollen grains on flying insects collected locally is an accepted method of establishing where the insects have been). Moreover, the chances of the pest pink bollworm mating with a closely related species are nonexistent. The only other two known species in this genus are found exclusively in eastern Australia, and their biology is very different from that of pink bollworm. Of the two, only the pink spotted bollworm is (very rarely) found in commercial cotton. Neither of these other species enters a diapause state and both are very restricted in their ability to adapt to foreign climates.

Our Objective

The goal of this project is different from most others requiring permits for release. While in most other cases people are trying to breed GM organisms to make products, protect crops, or improve crops, our

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organism is designed to self-destruct and prevent wild populations from breeding successfully.

We are trying to develop special strains of pink bollworm to improve classic SIT. For this to work, we have to rear large numbers of a special strain of pink bollworm with lethal genes. We have to assure ourselves that the vast majority of the mass-reared insects will retain the lethal trait. Experience teaches that such a process is possible to implement successfully on a large scale.

Genetic mutation is a fact of life. The lethal trait we put into the pink bollworm could very well mutate to a form that is not expressed (and therefore no longer be lethal, for example). If this happens, the reverted individual would presumably be able to reproduce successfully. For this to happen, however, that individual would have to avoid thousands of sex partners in the same locality and the chances of that happening are extremely low, probably less than one of us winning the lottery. In addition, any escapees from the released mass-reared insects would become instantly lost in the existing field populations.

Therefore, we can calculate that a certain amount of loss of the inserted lethal trait is acceptable because it would be diluted out by the high probability that such revertants would mate with partners that remain conditionally lethal. If reversion becomes rampant, then the success of ABC would fall back toward that of the present SIT. A low rate of reversion would not mean much anyway considering that it is a pest and already present.

ABC from Lab to Field

The key to pink bollworm transformation was a “jumping gene” called the *piggyBac* element. Heidi Wang found *piggyBac* while doing her postdoctoral work in the laboratory of Malcolm Fraser in the Biology Department at Notre Dame. Heidi was rearing viruses in culture of insect cells when she noticed a change in the spore formation of one batch. Subsequent analysis revealed that a *piggyBac* element had “jumped” from the cells into the virus, landing in the region of DNA responsible for spore formation. Aside from the absolute wonder at such an event, this source immediately suggests how a possible horizontal movement of a jumping gene might occur in nature (they could move around in viruses).

Lepidoptera are known to be susceptible to viruses and other microorganisms. That is why mass-rearing colonies must be kept scrupulously clean to prevent disease from taking hold. It is well established that crowding Lepidoptera in lab colonies leads to viral expression and colony collapse. Thus, viral infection in nature carries with it a potential source of horizontal movement; a closely related jumping gene could activate mobilization of an inert jumping gene like *piggyBac.* However, having made that point, no laboratory experiment could reveal the chances of this happening in nature. In addition, all of our work is directed toward a short-term release and a strain designed to be self-destructive. Indeed, if lab-reared insects produced viable offspring in the field, ABC would not work.

The chances of such a thing happening are finite and, carried forward to a day when ABC is being used practically, probably will occur on a regular basis. However, this must be balanced within the context. ABC will never be used as presently constituted except as part of an eradication exercise. However, once developed, we expect ABC to replace SIT and to be a new tool in population control.

Area-wide programs using SIT, pheromone treatments, and transgenic cotton have already been used in local areas and have lead to suppression of pink bollworm to below economic thresholds. As it stands right now, there is absolutely no danger associated with releasing the transgenic strain we have in culture. A climate of overreaction must be avoided if we are to develop these new tools.

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Bushwhacked by Arsenic?
Part I: Toxic Terror & Treated Wood

Dr. Allan S. Felsot, Environmental Toxicologist, WSU

Picture this television advertisement: a cute little five-year old hands her dad a drinking glass and innocently asks, "Can I have more arsenic in my water, please?" Seems like the political party out of power has finally found a winning theme as it exploits President Bush's decision to hold off revising the arsenic drinking water standard from 50 μg/L (micrograms per liter or a part per billion, ppb) to 10 μg/L.

Working another arsenic angle, the print media recently highlighted the hazards lurking in pressure-treated wood, also commonly known as Wolmanized® lumber (19). The characteristically green-colored wood is pressure treated with copper, chromium, and arsenic in a pesticidal mixture called chromated copper arsenate (CCA). Picking up on stories of men who became acutely ill after building decks and playgrounds with the lumber, the newspaper account highlighted arsenic as the culprit.

For those of us reared on black and white movies, "Arsenic and Old Lace" comes to mind, and, with it, a startling recognition—arsenic is poison! The late night talk shows are abuzz with arsenic jokes and county extension offices are receiving inquiries about the safety of treated wood in gardens and playgrounds. It's springtime and the honeymoon is over for President Bush.

Treated wood and drinking water don't have much in common, but both contain arsenic. This ubiquitous, naturally occurring element follows the laws of toxicology like everything else, so no doubt overexposure can lead to some nasty health effects. But what is the likelihood (i.e., risk) that you will be bushwhacked by arsenic from exposure in water or treated wood? In Part I, I revisit a 1994 essay I wrote about pressure-treated wood, "Toxic Terror in the Backyard" (9). In Part II, I will examine the issues behind the proposed lowering of the arsenic drinking water standard.

It's All Natural and Everywhere

Like it or not, you will be exposed to arsenic regardless of whether you have CCA-treated wood in your backyard. Arsenic (chemical symbol As) is one of the 103 naturally occurring elements; it has a natural abundance in rocks and soils. The soil concentration of As worldwide has been estimated to range from 1-50 mg/kg (milligram As per kilogram soil) (17). All plants, cultivated or wild, can absorb small amounts of this element. The extent of arsenic absorption varies among species and the amounts in the fruit often are lower than in the roots and shoots (32). From a chemist's viewpoint, arsenic is related to phosphorus, an essential element for plant growth. Indeed, arsenic may be taken up by plants because it is absorbed by the same physiological process used for uptake of phosphates (3). Thus, every time you eat, you ingest various amounts of arsenic. Unlike other metals known to be essential nutrients for good health, arsenic's necessity in the diet is still an open question (22).

Human Inputs of Arsenic

Although As is a naturally occurring, ubiquitous element, we have increased its concentration in soil by using lead arsenate insecticide. Most lead arsenate was sprayed on orchard crops; some was applied to vineyards and potato fields. Although registration of lead arsenate was officially rescinded in 1988, its widespread use ended by the early 1960s. The legacy is a lasting one, however, because lead arsenate residues can still be found in old orchards at levels of hundreds of parts per million (ppm or mg/kg) (24).

Arsenic is also added to soil in fertilizers, whether biological or mineral in origin. For example, rock phosphate, which is certified for organic agricultural production, may contain as much as 21 mg/kg As (25). Composted cow manure can contain 5 mg/kg (25). In contrast to lead arsenate sprays, the total addition of arsenic in fertilizers is much smaller and probably does not substantially change the background ("natural") levels of arsenic.

Arsenic also has widespread uses in metallurgy and the electronics industry, but these sources would produce defined point sources of environmental waste that are well regulated under the discharge laws of the Federal Clean Water Act (CWA) and the

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waste disposal laws of the Resource Conservation and Recovery Act (RCRA).

Arsenic in Treated Wood

The CCA process is used to treat wood against insect pests and the fungi that cause decay; arsenic is one of three elements involved. Wood is bathed in the chemical combination under pressure and heat. A chemical reaction “fixes” the chemicals in the cells of the wood, but small amounts can still leach out to the environment.

Depending upon its intended use (e.g., fencing, telephone poles, docks, decks), CCA-treated wood contains various amounts of arsenic. Most of the arsenic is in the inorganic chemical form called arsenate. Arsenate occurs in combination with hydrogen and oxygen, and it has a valence (“electronic charge”) of +5, meaning that it can potentially form chemical bonds with five other atoms. Thus, using the Roman numeral for “five,” arsenate is also known as As(V). The other important form of arsenic is called arsenite; it has a valence of +3 and is also combined with oxygen. As(III), the arsenite form, is considered much more toxic than As(V), the arsenate form (11). As(III) in the form of arsenic trioxide is the poisonous powder that worked its nefarious deeds in the movies, as well as throughout history (2). Pertinently from the viewpoint of human contact with CCA wood and environmental safety, a recently analyzed sample of treated lumber contained 2390 mg/kg As(V) but less than 50 mg/kg As(III) (4).

Hazards of Arsenic

Arsenic-containing compounds have a long history of use in technological and medical applications (2); arsenic’s potency as an acute poison was discovered long ago. Usually, human health effects of chemicals are deduced either from animal experiments or experiences with human suicide attempts. With arsenic, however, we have a good deal of human exposure information, including cases involving high doses in water or in the workplace over time periods ranging from months to years. Arsenic has also been used as a medication to treat various ailments, with occasional toxicity occurring from overdosing. We have learned, among other things, that arsenic seems potentially more toxic to humans than to other animals.

The symptoms characteristic of arsenic poisoning differ depending on whether exposure has been acute (a large dose given in a short period of time) or chronic (smaller doses over a longer period of time) (11). Arsenic in a single dose of 200-300 mg is often fatal, but sublethal, smaller amounts can lead to a plethora of effects after intermediate (several weeks to months) or longer (years) exposures.

Almost every physiological system can be adversely affected by arsenic if the dose is high enough and prolonged (11, 20, 21, 23). However, intermediate-term exposure to unusually high but naturally occurring levels in drinking water produces a very characteristic skin pathology and cardiovascular disease. The effects on skin have been dramatically illustrated in the news with pictures of citizens from Bangladesh having callus-like growths all over their extremities (a.k.a. palmoplantar hyperkeratosis), changes in skin pigmentation, and skin lesions (7) . This pathology, which has also been noted in South America, was prevalent in areas where rural inhabitants were drinking shallow ground water containing high levels of arsenic. Another pathology, noted in rural inhabitants of Taiwan and Chile, is blackfoot disease, a cardiovascular pathology akin to gangrene (21). Again, the affected inhabitants were drinking ground water with extraordinary levels of naturally occurring arsenic.

Acute exposures leading to arsenic intoxication may be first manifested as a flushing of the skin or or as contact dermatitis (severe skin irritation) (11). Symptoms would show up within days of exposure depending on the dose. Overexposure could lead to neurological symptoms of disorientation, headache, tremor, or convulsions. Gastrointestinal symptoms from overexposure range from abdominal pain to vomiting and bloody diarrhea. Bear in mind, however, that arsenic poisoning, unless extraordinary as in the case of intentional poisoning, will not result in symptoms

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immediately but will take a few days or longer to appear. Thus, simply handling or touching CCA-treated wood would not result in acute symptoms.

Prolonged exposure to high levels of arsenic in drinking water and in the workplace has been associated with several kinds of cancer, including skin, lung, and bladder (5, 22). The deduction of an association with cancer comes strictly from human epidemiological studies.

Arsenic Hazards Are Dose-Related

From the above brief summary of a few of the more graphic effects of arsenic on humans, you may be thinking that this naturally occurring compound is Mother's Nature's joke on us. I was amazed at the number of physiological systems affected by arsenic to the point of wondering whether all human ills might not be ascribed to arsenic exposure. From womb to tomb, we are exposed unavoidably to arsenic. Yet non-occupational arsenic poisoning is comparatively rare in the Western world.

Once again, dose is everything with regard to human toxicity for the simple reason that, following typical exposures, As does not accumulate in tissues and is fairly rapidly excreted. Thus, to assess the hazards from being exposed to environmental arsenic (whether the exposure is from food, water, or treated wood), a little background on arsenic fate in the body is necessary.

When ingested, As can be efficiently absorbed by the intestines (~80% of dose) in most cases and will quickly appear in the blood. Studies with dogs have shown that As ingested in soil is poorly absorbed by the intestine with an efficiency of only about 8% of the delivered dose (12). However, if exposed on the skin, only about 2-6% of the dose can be absorbed within 24 hours (22); in other words, skin makes a good protective barrier to As intake.

As(V) is the most prevalent form found in food, water, and treated wood. Once it gets into the blood it is quickly reduced to As(III). However, the liver rapidly detoxifies As(III) by transforming it to organic forms called monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA). These methylated metabolites are significantly less reactive and toxic than inorganic As and are rapidly excreted to give an overall As half-life (i.e., the time to excrete 50% of a dose) in the body of about 30 hours (31).

The toxicity to rodents of a single oral exposure supports the idea that As is more toxic to humans than to other animals (Table 1). If 200-300 mg can be lethal to a human, then a 70-kg male responds with an LD_{50} less than 3-4 mg/kg. Indeed, human exposures as low as 0.28 mg/kg from prolonged daily use of arsenic-containing medicines can produce symptoms of mild poisoning (8).

TABLE 1

Acute oral toxicity of inorganic and organic forms of arsenic (8, 31)

Compound (form if specified)	Animal	LD50 (mg/kg)
Sodium Arsenite As(III) solution	rat	15.1
Sodium Arsenite As(III) dry powder	rat	145.2
Sodium Arsenite As(III) solution	mouse	39.4
Monomethylarsonic Acid, MMA	mouse	1800
Dimethylarsinic Acid, DMA	mouse	1200

A "safe" level of exposure is difficult to define for inorganic As because of the constant daily exposure to very low levels and the wide range of effects attributed to variable levels of atypically high doses. The most sensitive body system (in terms of *exhibiting symptoms)* seems to be the skin. Skin disorders have been associated with As in drinking water at 0.01 mg/kg/day for prolonged periods (months to years) (23). This exposure level would translate to a 700 microgram (µg) daily dose in a 70-kg male or a 70-µg dose in a 10-kg two-year-old child.

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The doses associated with As intoxication tell us little about hazards without a knowledge of exposure levels. For the next step in deciding whether treated wood might cause harmful health effects, we have to look at whether direct or indirect contact with the wood could substantially increase our daily exposures (over and above what we already receive in our diet and water) to levels that are known to cause the various forms of arsenic toxicity.

How Much Arsenic Are We Naturally Exposed To?

With the U.S. Environmental Protection Agency's (EPA's) pre-Bush-administration rule to lower the drinking water standard for As and the political flak over President Bush's decision to reverse the changes, one would think that we are highly exposed to arsenic in drinking water. In fact, the vast majority of people in the U.S. are exposed to levels less than 10 µg/L (10). An adult drinking two liters of water each day would add 20 µg to her daily As intake.

An analysis of the U.S. Food and Drug Administration's Total Diet Study database for the years 1986-1991 showed that an adult's average daily dietary exposure to As is less than 30 µg (13). In the late 1970s, this value may have averaged 60 µg per day (31). Thus, if water consumption and the most recent value for dietary exposure are added, a typical adult may be exposed to 50 µg of naturally occurring arsenic per day. Because a young child (i.e., a two-year old) drinks less water (~1 liter of water per day) and eats less food, a child's daily exposure may be estimated as 18 µg per day (~8 µg from the diet) (13).

Does CCA-Treated Wood Increase Our Exposure?

The next question is how much more arsenic might we be exposed to if we come in contact with CCA-treated wood? Several exposure scenarios come to mind. If CCA-treated wood is used to build a deck, how much As will someone be exposed to if he rubs his hand across a railing? Will As leach out of the deck during rainfall and contaminate the soil underneath? If CCA-treated wood is used to line garden beds, will As leach out and contaminate the plants? I am not going to address the scenario of a carpenter working with the wood; this constitutes an occupational exposure and the worker should always use a dust mask and wash immediately after handling the wood.

Only a handful of studies have addressed the questions pertinent to consumers. These studies, however, share two common observations: (a) measurable amounts of As leach from CCA-treated wood, but (b) the increase in exposure to humans over what they would receive from background (diet and water) levels seems insignificant with respect to levels known to affect health. For example, two separate studies have examined As levels in soil directly underneath decks. In Florida, a study of nine decks showed average levels ranging from 0.48 mg/kg to 79.1 mg/kg (26). In Connecticut, average As in soils below decks ranged from 9 to 139 mg/kg (28). The background concentration of As in the Florida and Connecticut studies averaged 1.53 and 3.7 mg/kg, respectively. Thus, a child playing under the deck who ingested one gram of soil would potentially receive 139 µg of As. However, bear in mind that As is not absorbed efficiently from the gastrointestinal tract when it is in soil (12), so only about 14 µg would enter the bloodstream (~10% of ingested As in the soil). Furthermore, the child would be intermittently exposed to the soil, and As is quickly metabolized and passed from the body in two to four days.

The good news about the studies with decks is that soil samples taken six inches (15 cm) away from the deck perimeter had a reduction in As concentration of 85% (28), suggesting limited horizontal mobility of As, a limitation also indicated by a study of CCA-treated wood bulkheads along the shores of marine environments (30). Under these latter conditions, with constant water bathing the wood, one would predict high mobility of the As. Yet, the leached As drops off to near background levels at distances beyond three feet (one meter).

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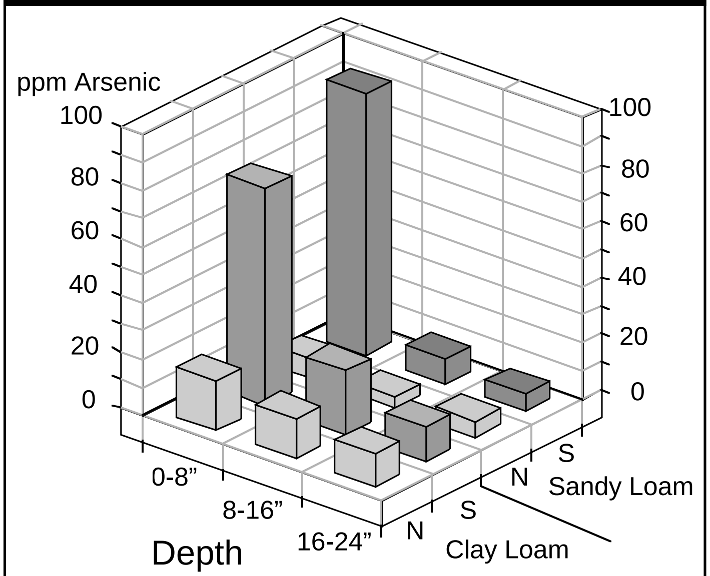
The downward mobility of leached As seems as limited as the horizontal movement. The Florida deck studies showed a rapid decline in As to background levels at an eight-inch depth (26). In another worst-case example, studies with lead arsenate-treated soils during the 1930s showed insignificant leaching below the top eight inches despite high concentrations resulting from repeated yearly spraying of the insecticide (15) (Figure 1).

FIGURE 1

Distribution of As to a depth of two feet in two Oregon orchard soils sprayed (S) or never sprayed (N) with lead arsenate insecticide (15). Note that arsenate is the main form of arsenic in CCA-treated wood.



Down the Garden Path

The mobility studies with As, along with studies showing that As can be significantly sorbed to soil (14), indicate that leaching from wood lining gardens would only move a small distance into the soil bed. Furthermore, increases in soil arsenic do not necessarily mean greater uptake by plants. The aforementioned soil sorption propensity also reduces arsenic's bioavailability (14). Studies with grape plants using CCA-treated stakes showed no detectable changes in the As content of vines, stems, or fruit (18).

In a worst-case situation (heavy use of lead arsenate spray), the magnitude of As uptake depends on the specific crop (6, 16). Crop uptake studies on lead arsenate-impacted soils of the Pacific Northwest have shown that As levels in carrots, peas, peppers, and tomatoes were not significantly affected by soil levels. However, beets, kale, eggplant, and lettuce seemed more efficient at bioconcentrating As residues (Table 2). Enhanced uptake of As by lettuce also occurred when plants were grown in a container with a block of CCA-treated wood or a sawdust containing 480 mg/kg As (27). However, when sawdust contained only 32 mg/kg As, uptake hardly changed over background levels. Given that the As uptake studies represent worst-case conditions of As contamination throughout the soil or plant growth adjacent to a piece of CCA-treated wood, the probability is very low that CCA-treated wood can impact As levels in garden plants enough to alter dietary intake.

A Hands-On Experience

CCA-treated wood is also used in playground structures ("playscapes"). It is reasonable to ask whether children playing on such structures will be exposed to harmful levels of arsenic. Two studies suggest that As can be transferred to the hand when a hand is rubbed across CCA-treated wood. In one study, the maximum amount of As removed by a dry hand moving over a new wood surface was 0.03 $\mu g/cm^2$ (1). When the hand was wet, 0.3 $\mu g/cm^2$ was removed. Another study used wet absorbent material to simulate a wet hand on a wood playscape and reported that an average of 0.08 $\mu g/cm^2$ was removed. The total surface area of both hands on a two- to three-year-old-child has been estimated to be 387 cm^2 at the 95th percentile (i.e., the hand's surface area is greater than the surface area in 95% of all other kids) (29). The palms and fingers alone could therefore be considered to have a surface area of 193.5 cm^2. Thus, under a worst-case condition where both hands would be placed in a child's mouth and all the As was sucked off and swallowed, the exposure could be as high as 15.5 μg (193.5 cm^2 x 0.08 $\mu g/cm^2$). Using a different set of assumptions, the "playscape" study author estimated an exposure of only 2 μg As (27).

...continued on next page

Bushwhacked, Part 1, cont.

Dr. Allan S. Felsot, Environmental Toxicologist, WSU

All Together Now

The worst-case increase in As exposure of a two-year-old child who plays on a CCA-treated wood structure and eats vegetables from a garden lined with treated wood can be estimated by combining the daily food and dietary intake with the exposure to the hands. The dietary intake could be increased by a factor of 25% just in case the kid likes eggplant or lettuce, although in reality these would be extremely small components of the diet. Thus, the total exposure could be 35.7 µg (18.1 µg from the diet plus an extra 2.1 µg from the garden plus 15.5 µg from the playground). In summary, the use of CCA-treated wood in a child's total environment could double As exposure under extreme circumstances.

TABLE 2

Arsenic residues (mg/kg dry weight) in various garden plants grown on lead arsenate sprayed and unsprayed orchard soils in Oregon (16). The levels of As in the sprayed soil ranged from 52 to 153 mg/kg compared to 2.7-5.3 mg/kg in unsprayed soils.

Edible Crop Part/Location	Unsprayed	Sprayed	Ratio Sprayed-to-Unsprayed
Central Station			
Carrot	0.42	0.24	0.6
Pea	0.08	0.13	1.6
Vetch Hay	1.61	2.54	1.6
Hood River			
Eggplant	8.11	26	3.2
Onion	0.47	0.47	1
Peas	0.53	0.64	1.2
Pepper	0.52	0.62	1.2
Medford			
Peas	0.05	0.05	1
Southern Oregon			
Alfalfa Hay	1.93	4.6	2.4
Beets	0.45	1.7	3.8
Kale	0.36	1.3	3.6
Lettuce	0.16	0.42	2.6
Tomato	0.11	0.13	1.2

What is the likelihood that such a doubling of As exposure in a child would cause harm? For pesticide risk characterization, we normally compare exposure to some reference dose (RfD) that has a very large built-in safety factor. The RfD is defined by the EPA as a daily dose over one's lifetime that is reasonably certain to have no harmful effects of any kind. Arsenic has not been assigned an RfD as an official "safe" level of exposure as is usual for pesticide risk characterization. However, the Provisional Tolerable Daily Intake (PTDI) developed by the United Nations' World Health Organization is used by the FDA to gauge the safety of daily As intake (13). The PTDI for As is 2.1 µg As per kg body weight per day. This represents an estimated daily dose over a lifetime for which there is a reasonable certainty of no adverse effects.

On a body-weight basis, a two-year old playing on treated wood could receive a dose of 3.6 µg/kg (i.e., 35.7 µg As per 10 kg body weight) . While this dose exceeds the PTDI, bear in mind several important factors that mitigate the hazard. First, the playground and garden vegetables exposure are intermittent while the food and water will be long-term daily events. The PTDI was designed conservatively to protect individuals from chronic exposures over a lifetime. For limited timeframes, exposures could exceed the PTDI without any adverse effects. Second, my calculation for ingestion of As from the child's hands did not consider the high likelihood that only a small fraction of the As would even make it into the mouth. If the arsenic remained on the skin only, then the child would be protected by the low efficiency of As dermal absorption. For these reasons, the likelihood of harmful effects from non-occupational exposures to CCA-treated wood are very low. Remember that As is detoxified and cleared from the body rapidly, so there is no buildup in tissues when exposures are low.

In conclusion, intimate contact with CCA-treated wood does not change arsenic exposure sufficiently to cause harm and current dietary and drinking water exposures seem well below levels known to cause harm. So why did EPA desire to lower the drinking water standard by fivefold? Stay tuned for the next essay, in which I will discuss the wonderful ways that mathematics has been used to make a safe drinking water supply even safer.

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Bushwhacked, Part 1, cont.

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Bushwhacked, Part 1, cont.

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What You Can Do

If You Are Still Worried About Arsenic from CCA-Treated Wood

If you are sawing treated wood, wear a dust mask, wear a shirt and long pants, and wash thoroughly when finished.

Do not make playscapes from CCA-treated wood; consider alternatives like cedar or synthetic materials.

Grow ornamental (as opposed to edible) plants near the borders of garden beds outlined in treated wood.

Restrict children's access to areas directly under decks made with treated wood.

Keep decks in good shape with sealants.

Never burn treated wood nor use the sawdust in mulch.

EDITOR'S NOTE:

The U.S. Environmental Protection Agency (EPA) released a press advisory May 10, 2001, stating the following:

On May 9, 2001, EPA met with representatives of the wood-treatment industry, including manufacturers and retailers, and with representatives of environmental and public interest groups, to discuss the current status of EPA's reassessment of CCA*-treated wood and to evaluate efforts for informing the public about the safe use and handling of pressure-treated wood. Both meetings featured constructive and direct discussion regarding safety information available to consumers about CCA-treated wood. Industry participants committed to submit a proposal to EPA in two weeks for strengthening consumer safety materials. A public meeting will be convened in early June involving EPA and all stakeholders, to further discuss efforts to strengthen consumer safety information related to CCA-treated wood. EPA is currently reviewing all available scientific information to conduct a thorough and comprehensive reassessment of CCA-treated wood. As part of this reassessment, the Agency is expediting a risk assessment, expected to be completed in June, focusing on children's potential exposure from playground equipment constructed with CCA-treated wood. EPA remains committed to ensuring ample opportunity for public involvement in all aspects of this process.

(*CCA = Chromated copper arsenate; see preceding article.)

QBL Cancels Registrants' Royal Reprieve

Jane M. Thomas, Pesticide Notification Network Coordinator, WSU

Hello. It is I again, the Queen Bee of Labels (QBL). Some of our loyal (royal) readers may have noticed that it has been awhile since the QBL graced these pages. In fact, the QBL has not had much to say since she got graphic back in the December issue of this upstanding newsletter ("The QBL Gets Graphic," *AENews* Issue No. 176). The start of 2001 was the beginning of a Registrants' Royal Reprieve. Over the last few months, the QBL has shown restraint and has refrained from assisting registrants by pointing out examples of their lousy pesticide labels. During said Reprieve, no Non-Anom Awards (see *AENews* Issue No. 171, July 2000) have been handed out; no registrants have been called on the carpet to atone for their misdeeds.

The QBL thought it both refreshing and useful to grant a Royal Time Out. Envisioning a period during which each registrant examined its own soul and reflected on its various wayward pesticide labels, the QBL hoped that the registrants would take the opportunity to ponder (and execute) some positive changes. Moreover, Her Royal Highness (HRH) thought perhaps this Reprieve period would give the U.S. Environmental Protection Agency (EPA, the governmental entity ostensibly in charge of reviewing pesticide labels) time to do the right thing and simply appoint HRH to her rightful position as the Queen Bee of Labels, thereby making all things right (see "If I Were The Queen of Labels," *AENews* Issue No. 169, May 2000).

Back on the Throne

Well, the QBL hopes that you have enjoyed this Reprieve because it has now come to an end. Sad to say, despite the Time Out, EPA has not been forthcoming with the job offer, registrants did no (or insufficient) soul searching, and things in the world of pesticide labels are still a mess.

The termination of the Reprieve was brought about by an outstanding example of this mess: Rohm & Haas' Confirm T/O label. Indeed, this label caused the QBL to have the following Royal Revelation: T/O does not stand for (or in any way imply use on) Turf and Ornamentals. (That said it occurs to the QBL that perhaps one should not admit to having Revelations because it does seem to indicate a certain lack of omniscience.)

Prior to this Revelation, which really rocked the royal socks, the QBL had been under the mistaken impression that when a registrant included T/O in a product name that this stood for Turf and Ornamental. What? You thought so, too? Consider yourself in not only good, but royal, well-bred, soft-spoken, kind, thrifty, cheerful, and lofty company. But there you have it: the QBL is once again spilling the beans, revealing a previously unknown "truth" about pesticide labels: T/O ≠ Turf/Ornamentals.

A Freshly Minted Problem

The Confirm T/O label initially came to the attention of the QBL through a problem unrelated to either its T or its O.

The Royal wRath was drawn by a notation by Rohm & Haas on the cover sheet for the revised label (ooh and don't get the QBL started on the whole revision process—see *AENews* Issue No. 173, September 2000) stating that mint uses had been added to the label. Because the trusty staff at Washington State University's Pesticide Information Center (PIC) actually read pesticide labels, and because, when doing so, they could not find any directions for mint on the label, the QBL herself called Rohm & Haas. It should be noted here, in the event that it is not obvious, that when a pesticide label causes such confusion that the QBL must pick up the phone and make a call for clarification, all things are not coming up roses for the registrant in question. After several false starts, where the QBL was informed that of course mint use directions were included on the label, it finally came to light that the label cover was in error and that Confirm T/O was in fact not labeled for use on mint.

Then came the Royal Revelation (T/O ≠ Turf and Ornamentals). While cooling the royal heels on "hold" as Rohm & Haas searched in vain for the word "mint," HRH the QBL noticed that the Confirm T/O label

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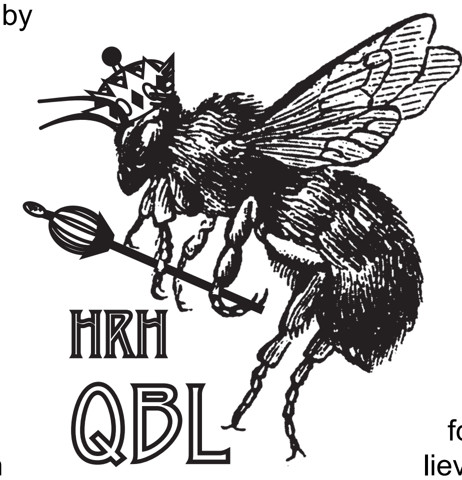
Royal Reprieve, cont.

Jane M. Thomas, Pesticide Notification Network Coordinator, WSU

contains use directions for ornamentals, bushberries, caneberries, cole crops, leafy vegetables and turnips, fruiting vegetables, pome fruits, pecans, and walnuts; any directions for turf use were conspicuously absent. Not one to be put off by dealing with a wayward registrant, after resolving the Mint Issue, the QBL went on to ask why was the label designated as Turf and Ornamental when it clearly was intended for other crops? HRH was informed that the T/O designation was sometimes used by registrants to designate products packaged in smaller container sizes that are also intended for home-owner use. Whereupon the QBL reviewed the facts. Indeed, Confirm T/O is a one-quart package. However, the directions for all uses except ornamentals are given in per-acre rates; only the QBL's more ambitious friends tend multi-acre home gardens. The Rohm & Haas representative agreed that this was problematic. Reading in more detail, the application directions for cole crops, leafy vegetables and turnips, fruiting vegetables, pome fruits, pecans, and walnuts all discuss using conventional ground equipment while the application directions for the berries states "Make applications by conventional boom or air-blast sprayers." While the QBL does acknowledge that there are directions for using a hand sprayer to treat ornamentals, she does not consider application by air-blast sprayers to be one for home and garden use.



Terminology Orphans?

In days of yore, when T/O still stood for Turf and Ornamental, why might Rohm & Haas have called this product Confirm T/O? As turf uses are not included on the label, why not just call the product Confirm-O? After all, it has a nice ring to it and a good beat. But in truth, while Confirm-O is closer to the truth, the QBL can see that, sounding a lot like Wham-O or Blam-O, this name might not be such a hot idea. All right, if Confirm-O was not really an option, how about Confirm O Plus to indicate a product for use on Ornamentals "and other stuff?" If Rohm & Haas decides it can't live with that, then the QBL suggests Confirm Misc as a viable alternate.

But then back to the Royal Revelation: T/O ≠ Turf and Ornamentals. If not Turf and Ornamental, then what *does* T/O mean as part of a pesticide product name? In the case of Rohm & Haas, it seems apparent that T/O indicates crops not otherwise wanted on another label. Some suggested answers are:

This Stuff and **O**ther Stuff
Truth **O**scillations
Terminally **O**bsolete
Tired **O**dds & Ends
Twaddle **O**nly
Terminology **O**rphans

After pondering this weighty issue for quite long enough, the QBL believes that T/O really stands for **T**oken **O**fferings. If you think that you have a better idea, please feel free to let the QBL know but be forewarned: this is Monarchy. While you are free to speak, you may not be heard.

Once the Queen Bee of Labels is appointed to her rightful place at EPA, Rohm & Haas might want to reconsider their whole approach to pesticide labeling. The QBL has a long memory and it will be years before the Confirm-O indiscretion is forgotten.

Jane M. Thomas reigns from WSU's Pesticide Information Center, where she bides her time as Pesticide Notification Network Coordinator until her Phone Call from EPA comes. Until that time, she can be reached on a regular telephone at (509) 372-7493 or on common e-mail at ***jmthomas@tricity.wsu.edu****.*

For more QBL observations and scathing commentaries, see AENews *Issues No. 169, 171, 172, 173, 175, and 176. Issue dates are May, July, August, September, November, and December, 2000, respectively.*

Thrips and Onions
Field Observations 2000

Dr. Douglas B. Walsh, Entomologist, WSU

Last month, thrips were presented as the *AENews* Pest of the Month. This month, I will detail a pair of field studies involving thrips in dry bulb onions. I undertook these studies in the summer and fall of 2000 in response to complaints from dry bulb onion growers that they can't control thrips with pyrethroid and organophosphate insecticides.

Pyrethroid Tolerance Study

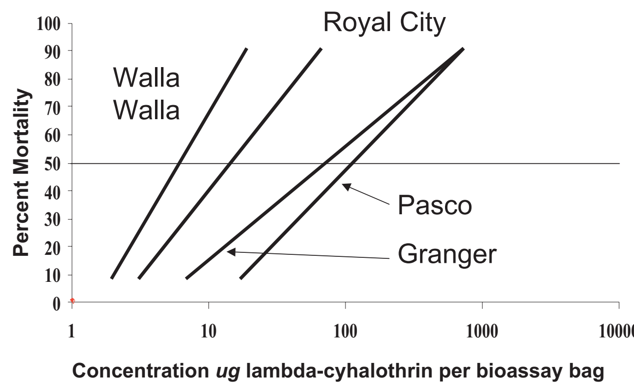
In August 2000, we surveyed thrips populations in four separate onion fields in Central Washington (near Royal City, Granger, Pasco, and Walla Walla). The onion field in Granger had been treated four times with lambda-cyhalothrin. The field in Royal City had been treated once with cypermethrin, twice with lambda-cyhalothrin and once with methyl-parathion. The field in Pasco had been treated twice with lambda-cyhalothrin and the field in Walla Walla had been treated once with lambda-cyhalothrin. No onion thrips were present in the onion fields near Royal City, Pasco, and Granger; only western flower thrips were found in those fields. The only site in the study that contained both thrips species was the Walla Walla field.

Suspecting the thrips might be developing pyrethroid tolerance, we conducted tolerance tests.* Levels of lambda-cyhalothrin tolerance were high in Pasco, Granger, and Royal City. There was substantial variation in the dose response in Walla Walla; some of the individuals in that thrips population remained susceptible to lambda-cyhalothrin (Figure 1).

These findings led me to speculate that western flower thrips were replacing onion thrips over the course of the season in onion fields after the fields were treated with pyrethroid insecticides. Pyrethroid insecticides are more lethal to onion thrips than they are to western flower thrips, so the latter became predominant.

FIGURE 1

Dose response of four western flower thrips populations in south-central Washington State to the pyrethroid insecticide lambda-cyhalothrin in August 2000.



Storage Contamination Study

Thrips have the potential to remain problematic beyond the field. Do thrips remain in the onion bulbs through harvest? Do they continue to persist in stored onion? These are critical questions for onion growers. The sites where thrips feed on the onions may create entry points for such storage diseases as botrytis gray mold, *Penicillum*, and aspergillus.

To help answer these questions, I treated a small plot of onions in a commercial onion field near Royal City in early September 2000 with chlorfenapyr. Chlorfenapyr is a non-registered anti-metabolite insecticide that proved to be a very effective thrips control compound in work I did on strawberries in California several years ago. In addition to my chlorfenapyr treatment, this entire onion field had been treated twice with lambda-cyhalothrin. In early October 2000, we harvested the chlorfenapyr-treated plot as well as an equivalent number of commercially treated onions from a nearby section of the field.

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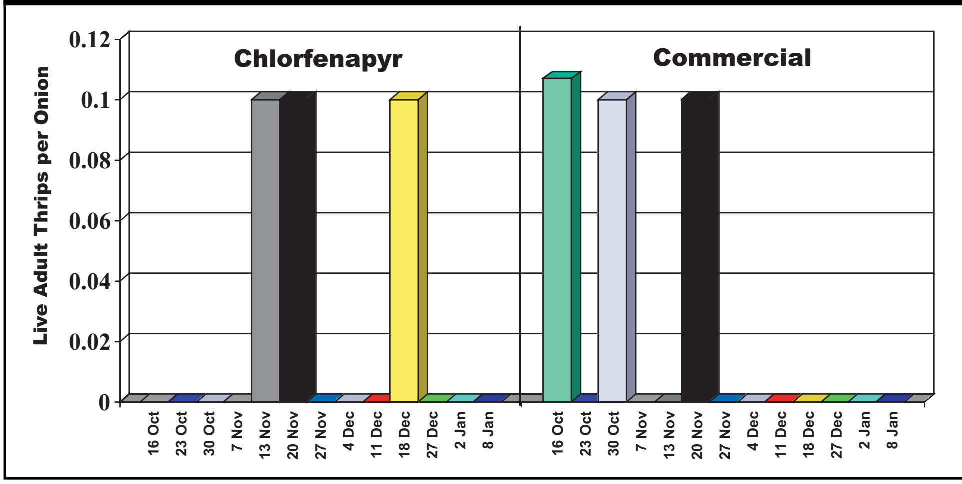
*Tolerance tests were conducted on western flower thrips to the insecticide lambda-cyhalothrin using the Brindley bioassay-bag technique described in "Portable incubator and its use in insecticide bioassays with field populations of lygus bugs, aphids, and other insects including *Acyrthosiphon pisum* and *Lygus hesperus*," by W. A. Brindley, D. H. Al-Rajhi, and R. L. Rose, which appeared in the Journal of Economic Entomology, Issue No. 75, pp. 758-760, 1982.

Thrips & Onions, cont.

Dr. Douglas B. Walsh, Entomologist, WSU

The onions were held in storage chambers at Washington State University Prosser; the chambers were climate-controlled to between 47° and 50°F and 65% relative humidity. We surveyed sub-samples of ten onions from the chlorfenapyr-treated plot and the commercial plot each week throughout the fall and into early winter 2001, counting and recording the presence of live adult or nymph thrips (Figures 2 and 3) and observing and recording the incidence and severity of disease (Figure 4).

FIGURE 2

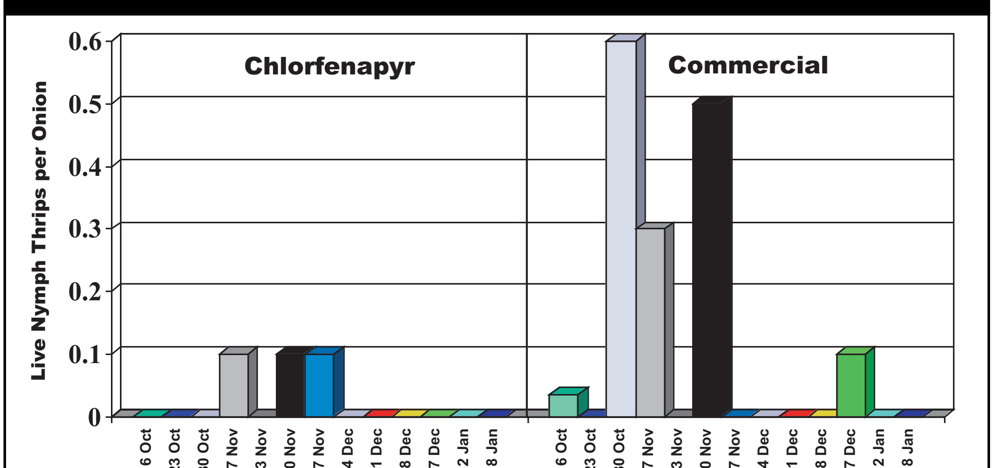


Adult thrips populations were low in the stored onions: around 0.1 thrip per onion (Figure 2). However, it was surprising to observe live adult thrips after two months of storage. Live nymph thrips populations were substantially higher in the commercially treated onions at between 0.6 and 0.3 nymph per onion compared to about 0.1 thrip per onion in the chlorfenapyr-treated onions for the first several weeks after the onions were placed in storage (Figure 3). No live adult or nymph thrips were observed after mid-December.

Disease ratings consisted of evaluating the "necks" of the onions for the presence of orange (aspergillus) or gray mold (botrytis). On the Brophy Onion Disease Scale (0 to 5, 0 = no visible disease present and 5 = "yuck" or inedible), disease never surpassed a 2. However there was a definite trend toward an increased incidence of disease in the commercially treated onions compared to the chlorfenapyr-treated onions.

The results of these field surveys indicate that the chlorfenapyr treatment was effective in suppressing thrips populations.

FIGURE 3



Future Implications

As registration for chlorfenapyr in onion is not being sought, research on other effective chemicals is needed. We will be expanding our studies on thrips in dry bulb onions with grants I have received from the Washington State Commission on Pesticide Registration, the Pacific Northwest Vegetable Association, and the Columbia Basin Vegetable Seed Associa-

...continued on next page

Thrips & Onions, cont.

Dr. Douglas B. Walsh, Entomologist, WSU

tion. I thank Gary Pelter, (WSU Cooperative Extension, Grant County), Ron Wight and Melinda Brophy (WSU Prosser) and Dr. William Brindley (Utah State University) for their assistance with these studies.

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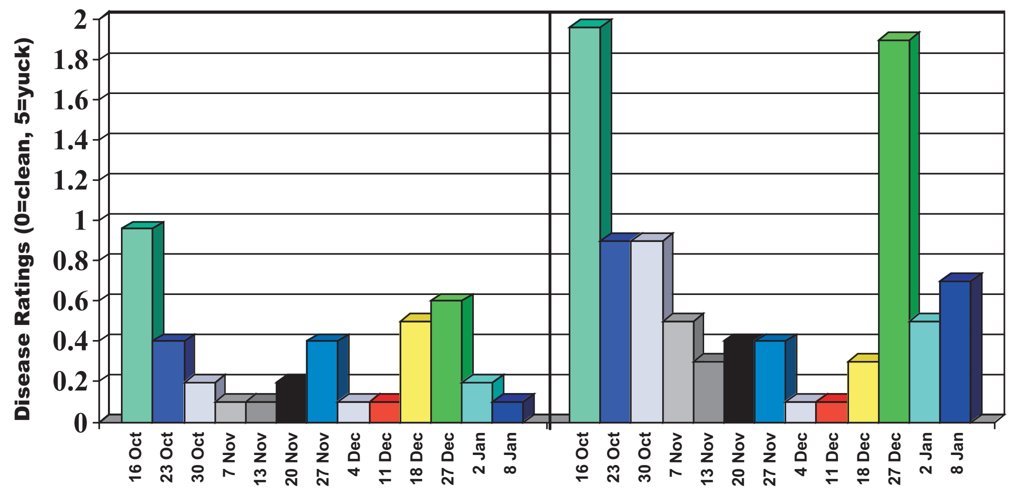
FIGURE 4



WSDA Waste Pesticide Collection

The Washington State Department of Agriculture periodically collects waste agricultural and commercial grade pesticides from residents, farmers, business owners, and public agencies free of charge. The goal of this program is to properly dispose of unused or unusable pesticides, eliminating these as potential sources of contamination to the environment. Since disposal is complex, participants must register prior to an event to allow WSDA and the waste contractor to determine the types and amounts of pesticides that will be collected. To register, or for more information, contact WSDA at **(877) 301-4555.** Summer collection events are shown here. For a complete schedule, including fall and eastern Washington dates and locations, point your Internet browser to **http://www.wa.gov/agr/pmd/pesticides/WasteSchedule2001.htm**.

Collection Site (Nearest City)	Collection Event Date	Registration Deadline	Inventory-to-WSDA Deadline
Bremerton	July 17	May 30	June 12
Seattle	July 18	May 30	June 12
Bellevue	July 19	May 30	June 12
Long Beach	August 20	July 12	July 24
Grays Harbor	August 21	July 12	July 24
Forks	August 22	July 12	July 25
Port Townsend	August 23	July 12	July 25
Shelton	August 24	July 12	July 25

2001 Pesticide Container Recycling Schedule

Washington Pest Consultants Association

Washington Pest Consultants Association (WaPCA) has been involved in recycling plastic pesticide containers since the early 1990s. They organize an annual series of collection dates and sites, contracting with Northwest Ag Plastics to collect and granulate the plastic containers. Dates, times, and locations are subject to change; use the contact information to confirm. For general questions, or to host an event at your farm, business, or in a central location in your area, contact Clarke Brown at (509) 965-6809, Dave Brown at (509) 961-8524 (**dbrownwash@msn.com**), or the Northwest Ag Plastics office at (509) 457-3850. THERE IS NO FEE FOR THIS SERVICE.

DATE	TIME	LOCATION	SPONSOR	CONTACT	PHONE (509)
6/1	8a-10a	Kennewick	Valley Roz #3	Charlie Slover	783-3513
6/4	9a-3p	Outlook	Snipes Mtn. Trans. Stn.	Mark Nedrow	574-2472
6/5	9a-3p	Terrace Hts.	Terrace Hts. Landfill	Mark Nedrow	574-2472
6/6	8a-10a	Whitstran	Simplot	John Cullen	973-2245
	1p-3p	Hanks Rd.	Olsen Brothers Farms	Keith Oliver	781-1106
6/7	8a-10a	Sunnyside	Bleyhl Farm Sevice Inc.	Vern Bos	839-4200
	1p-3p	Zillah	Bleyhl Farm Sevice Inc.	Dan Simmons	829-6922
6/18	8a-10a	Spokane	WSDA	Tim Schultz	533-2686
			WSU Coop. Extension	Jim Lindstrom	533-2690
	1p-3p	Mead	Cenex	Todd Race	466-5192
6/19	8a-10a	Deer Park	Inland Agronomy	Jim McAdam	276-2611
	2p-4p	Davenport	Northwest Aviation Inc.	Lee Swain	725-0011
6/20	8a-10a	Wilbur Airport	Greg's Crop Care	Greg Leyva	647-2441
	1p-3p	Odessa	Smith Air Inc.		982-2231
6/21	8a-11a	Moses Lake	Tom Dent Aviation	Tom Dent	765-6926
	2p-4p	Moses Lake	Moses Lake Air Service	Perry Davis	765-7689
6/22	8a-10a	Warden	Wilbur Ellis	Brian Preston	349-2333
7/3	8a-10a	Palouse	McGregor Company	Dale Deerkop	878-1321
	1p-3p	Garfield	McGregor Company	Ted Deerkop	635-1591
7/5	8a-10a	Palouse	Dale's Flying Service	Dale Schoeflin	878-1531
	1p-3p	Garfield	Cascade Flying Service	Doran Rogers	635-1212
7/6	8a-11a	Rosalia	Western Farm Service	John Hartley	523-6811
7/9	1p-3p	Pasco	Air Trac	Gerald Titus	547-5301
7/10	8a-10a	Eltopia	Wilbur Ellis	Vern Records	297-4291
	1p-3p	Eltopia	Eastern Wa Spray Serv.	Willis Maxon	297-4387
7/11	8a-10a	Pasco	Pfister Crop Care	Steve Pfister	297-4304
	1p-3p	Connell	B&R Crop Care	Chris Eskildsen	234-7791
7/12	8a-10a	Othello Airport	Conner Flying Inc	Mark Conner	488-2921
	1p-3p	Connell	L&L Farms	Dean Cockran	521-2728
7/13	8a-10a	Bruce	Cenex	Lori Anderson	488-5261
	1p-3p	Bruce	Simplot	Chuck Spytex	488-2132
7/17	8a-10a	Tonasket	Wilbur Ellis	Mel Schertenleib	486-2244
7/18	8a-11a	Brewster	Wilbur Ellis	Brian Hendricks	682-5315
7/19	8a-11a	Chelan	Wilbur Ellis	Brian Hendricks	682-5315
7/20	8a-11a	Cashmere	Wilbur Ellis	Ron Johnson	782-2301
	1p-3p	Wenatchee	Wilbur Ellis	George Craig	663-8753
7/24	8a-11a	Yakima	Wilbur Ellis	Doug Whitner	248-6171
7/25	8a-10a	Granger	Ag Air	Lenard Beierle	865-1970

CONTAINER CRITERIA

Rinsed—no residue

Clean and dry, no odor

Majority of foil seal removed from spout

Hard plastic lids and slip-on lids removed

Glue-on labels may remain

Half-pint, pint, quart, 1 gallon, 2.5 gallon, & 5 gallon containers accepted whole

For 30 and 55-gallon containers, call (509) 457-3850.

This table shows June and July dates only; a full schedule of dates through October is available on-line at **http://pep.wsu.edu/waste/wapca.html**.

FEQL Advisors Meet

Issues Include Spreading the Word

Marilyn Perkins, FEQL Advisory Board Chair

The fifth meeting of the Food and Environmental Quality Laboratory (FEQL) Advisory Board was held on the Washington State University (WSU) Tri-Cities campus April 17, 2001. Eleven board members were present, along with six representatives of FEQL/WSU.

With board chair Scott McKinnie's term ending June 30, 2001, the first order of business was election of officers. As chair-elect, I accepted the nomination for board chair for the coming year (July 2001 through June 2002) and was elected. Board member Don Abbott from the Washington State Department of Ecology was elected vice-chair/chair-elect.

Seventeen board member positions, each representing a different aspect of Pacific Northwest agriculture, food safety, and environmental quality, are mandated by the Washington State legislation that created the FEQL and its board. Two of those positions, one representing farm labor and one representing food processing, will become vacant June 30, 2001. The FEQL board is accepting suggestions for qualified individuals who can fill those positions. Parties wishing to recommend a farm labor or food processing representative can contact me or any other member of the FEQL staff or advisory board until July 1, 2001.

(Other board member positions and their current representatives are as follows: health care professional knowledgeable in worker exposure to pesticides, Matt Keifer, Pacific Northwest Agriculture Safety and Health Center; WSU research administrator, James Zuiches (Dean of the College of Agriculture and Home Economics); Washington State Department of Agriculture, Royal Schoen; Washington State Department of Ecology, Don Abbott; Washington State Department of Health, Barbara Morrissey; Washington State Department of Labor and Industry, Janet Kurina; privately owned Washington State analytical laboratory, John Peterson, Englar Food Laboratories; federal regional pesticide laboratory, Rick Long, US Food and Drug Administration; an Idaho laboratory, Gregg Möller, University of Idaho; an Oregon laboratory, Jeff Jenkins (to be replaced by Kim Anderson after June 30, 2001), Oregon State University; chemical/fertilizer industry representative, Scott McKinnie, Far West Agribusiness Association; farm organization, Dave Winckler, Ironwood Orchard; marketer, Wally Ewart, Northwest Horticultural Council; environmental organization, Peggy Adams, Palouse-Clearwater Environmental Institute. As a representative of the League of Women Voters, I hold the consumer position.)

In the wake of a state budget cut scare that occurred in late March, the board discussed the need to communicate the value of the FEQL to legislators and other audiences, including the agricultural community, the general public, and the university itself. These stakeholders need to understand the important work that the FEQL is doing. Allan Felsot submitted a statement that describes the FEQL and its impact on our state:

> The FEQL was mandated by the Washington State Legislature to focus research and extension efforts on all aspects of crop protection technologies across the state. The need for such a WSU facility grew out of two concerns: potentially devastating losses of crop protection tools for the minor crops characteristic of Washington agriculture and the safety of these tools to human health and the environment. The FEQL faculty have developed a productive program over the last eight years to readily address these divergent issues. The programs are valued by the general public, which can directly obtain information from the FEQL about the use and safety of all types of pest control technologies used in rural and urban environments. The programs are also valued by the agricultural industry for providing objective and critical analyses of current environmental regulations and issues, as well as conducting applied research on best management practices that help make agriculture even safer. For example, the FEQL studies pesticide drift and solutions for management and resolution of conflicts. FEQL faculty have been studying application of crop production agents through drip irrigation systems that are extremely critical to the

...continued on next page

FEQL Meeting, cont.

Marilyn Perkins, FEQL Advisory Board Chair

Yakima Valley for improving water use efficiency. In cooperation with the WSDA and the ODA, the FEQL faculty maintain a publicly accessible Internet database on all pesticide registrations in Washington and Oregon. Literally tens of thousands of Washington residents are reached each year through the extension services of the FEQL. FEQL faculty teach courses in environmental chemistry and toxicology, subjects that are extremely important to the promulgation of science-based human health and environmental legislation. In short, the philosophy of the FEQL program is to provide information and innovative solutions to citizens of Washington State.

Board members and FEQL staff discussed ways to disseminate the message that FEQL is doing good things for Washington State, including offering tours of the lab, mentioning FEQL and its projects during public speaking opportunities, and making *Agrichemical and Environmental News* available to a wider audience.

FEQL faculty members Doug Walsh, Vince Hebert, Allan Felsot, and Catherine Daniels gave presentations on the status of their respective programs. Dr. Walsh discussed his entomological field work and presented a list of projects, publications, and speaking engagements. Dr. Hebert explained the lab's progress toward Good Laboratory Practices (GLP) certification and discussed his various projects, including "Maintenance of Guthion and Sevin Registrations on Pome Fruits" underway with Dr. Felsot. Dr. Felsot described his current teaching, extension, and research activities, including a recent project "Assessing the Safety of Herbicides for Vegetation Management in the Missoula Valley Region." Dr. Daniels presented the status of her programs, including the Pesticide Information Center (PIC) and its various activities: the *Agrichemical and Environmental News*, the Pesticide Information Center On-Line (PICOL) database (**http://picol.cahe.wsu.edu**), and the Pesticide Notification Network (PNN, **http://www.pnn.wsu.edu**). She detailed projects underway in response to mandates from federal 406 funding, all of which need to be completed by September 1, 2001: a new pest management web page, eight crop profiles, and initiation of a pest management strategic plan.

The board also heard a presentation from Washington Association of Wheat Growers' Gretchen Borck about recent issues and controversies between environmental groups and wheat farmers over residue (wheat stubble) burning. A Spokane-based environmental group called Save Our Summers (SOS) is alleging harm from farming practices that may be subject to interpretation via the Americans with Disabilities Act, while wheat growers maintain that burning is a well-conceived best management practice tool that works in concert with no-till production systems to safeguard land from erosion and a host of other problems.

The FEQL Advisory Board will meet again in November 2001.

Marilyn Perkins is a member of the League of Women Voters of Washington and Chair of the FEQL Advisory Board. She can be reached at (509) 783-8610 or at ***perkinsjohn@msn.com****.*

Editor's Note

In last month's issue (*AENews* No. 181), the final line of Bill Duncan's article, "Making Monkeys Out of Environmentalists," page 18, was inadvertently truncated at press time. This line should have read, *"This article appears here with permission of both* Capital Press *newspaper and the author."* We apologize for any inconvenience this omission may have caused. Bill Duncan and *Capital Press* were both recognized, but permissions were not stated explicitly.

WSU Awards Recognize Excellence

Agrichemical & Environmental News Staff

Washington State University's College of Agriculture and Home Economics (WSU CAHE) recognized outstanding contributions to teaching, research, and extension activities at its 42nd Annual Awards Banquet and Program, April 21st, 2001. Faculty members recognized included Dr. William Johnston, Associate Professor of Crop and Soil Sciences; Dr. Richard Zack, Assistant Professor of Entomology; Dr. Markus Flury, Assistant Professor of Crop and Soil Sciences; Dr. Barry Swanson, Professor of Food Science and Human Nutrition; and Dr. Allan Felsot, Environmental Toxicologist at the WSU Food and Environmental Quality Laboratory.

Dr. Johnston received the college Alumni Association Undergraduate Advising Award. He has been a member of the WSU faculty for twenty years. He teaches turf and forage classes, conducts workshops, and coordinates the Crop and Soil Sciences Department's internship program. He also serves as chair of his department's scholarship committee, as a member of the department's undergraduate curriculum committee, and advisor of the student Turf Club. He has advised an average of twenty-eight undergraduate and graduate students the past four years.

Dr. Zack received the R.M. Wade Excellence in Teaching Award. Zack has been at WSU for twenty years. He was instrumental in increasing the enrollment of Entomology 101 from twenty-three students when he began teaching the class in 1997 to more than ninety in 2000. Altogether, his six classes account for almost half of his department's undergraduate enrollment. Zack practices his delivery the night before each class he teaches. The result is a lecture that appears to be extemporaneous, according to John Brown, department chair. "Students repeatedly identify Dr. Zack as the best instructor they have had at WSU."

Drs. Flury and Swanson were named co-winners of the Faculty in Research Award. Flury has been at WSU for four years. His research spans the field of soil physics, from the transport of viruses, radio nuclides and dyes to the development of novel means of determining fundamental physical properties of soils. Swanson has been with WSU since 1974. He has an international reputation for research on grain legumes, sugar-fatty acid polyesters for fat substitutes, non-thermal food processing, and food safety.

Dr. Felsot, a tireless ambassador of agricultural science, received the Extension Faculty Excellence Award. Dr. Felsot averaged fifty presentations a year the past two years, on topics ranging from biotechnology and transgenic crops to salmon, water quality, and pesticides. He has been with WSU for eight years. As readers of *AENews* know, Felsot tackles tough issues. He has worked with disputing growers in Badger Canyon and the Horse Heaven Hills over long-standing allegations of pesticide drift. Tests he conducted found that direct drift from the Horse Heavens was not causing herbicide injury to crops.

AENews editorial staff thanks the WSU CAHE Information Department for their assistance with these announcements and congratulates these deserving award winners.

First International Precision Forestry Symposium

The University of Washington campus will host the First International Precision Forestry Symposium June 17 through 19, 2001. Information and registration forms are available on the Internet at

http://www.cfr.washington.edu/Outreach/PreFor/index.html

or contact Program Coordinator Christine Scannell, Forestry Continuing Education,
Phone: 206-543-0867 • Fax: 206-685-6705 • E-mail: forestce@u.washington.edu

Pest of the Month
Lygus Bug

Doug Walsh, Extension Entomologist, WSU

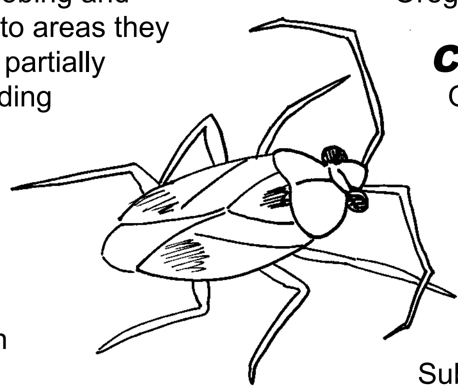
The Lygus bug, *Lygus hesperus,* is native to the Pacific Northwest. It is known to be an agronomic insect pest of many crops, including apples, apricots, caneberries, dry beans, forage (alfalfa) seeds, lentils, lima beans, pears, plums, prunes, potatoes, snap beans, spinach, strawberries, sugar beets, and several vegetable seed crops (1).

General Description

Lygus are "true bugs." They have piercing, sucking mouthparts in the form of slender, segmented beaks that arise from the front of their heads and extend back along the ventral (lower) sides of their bodies.

Crop Damage

Lygus feeding has been likened to chemical injury. The bugs insert their mouthparts into plant tissue and inject digestive enzymes. After probing and injecting for awhile, Lygus return to areas they previously probed and ingest the partially digested plant tissues. Lygus feeding damage can vary from crop to crop. In cotton, Lygus feeding can cause flower bud abortion, death of plant terminals, and staining of lint. In fruit and pod vegetable crops, feeding results in cosmetic quality loss. In seed crops, Lygus feeding often results in a reduction of seed set.



Habits and Life Cycle

Lygus in the Pacific Northwest have an extensive host range of both introduced and exotic plants and weeds including burclover, Canada thistle, chickweed, common groundsel, curly dock, filaree, horseweed, kochia, knotweed, lambsquarters, lupine, mullein, mustards, pepperweed, pigweed, pineappleweed, rabbit brush, ragweed, redmaids, Russian thistle, sage, shepherd's purse, smart weed, smotherweed, sweet clover, and wild radish.

Lygus are highly mobile. They are strong flyers and have been documented to fly as far as thirty miles in cotton-growing regions of California.

Lygus overwinter as adults in plants and plant debris, becoming active as temperatures warm in spring. They mate soon after emerging; mated females begin laying eggs several days later. Lygus develop through five nymphal instars (larval stages) before emerging as adults.

Entomologists in California developed a model correlating climate to biological changes (known as a "phenology model") that proved effective at predicting the timing of Lygus generation cycles (3). This model has been tested in eastern Washington and has proven relatively accurate at predicting the first-generation hatch of Lygus in spring. However, the model is less accurate as spring progresses (2). Lygus bug populations typically will complete three generations per year in eastern Washington, eastern Oregon, and western Idaho.

Control

Organophosphate, carbamate, and pyrethroid insecticides have all been used extensively to suppress Lygus populations across a wide range of crops. Dan Mayer (WSU) and Bill Brindley (Utah State) have documented insecticide resistance in Lygus populations infesting alfalfa and vegetable seed crops. Substantial efforts have been made at developing biological control programs for Lygus. Unfortunately, these programs do not generally reduce Lygus populations below economically damaging levels on many high-value crops like alfalfa seed.

Dr. Doug Walsh is an Extension Entomologist with WSU. He can be reached at (509) 786-2226 or ***dwalsh@tricity.wsu.edu.***

REFERENCES

1. 1999. Pacific Northwest Insect Control Handbook
2. Mayer, D. 2001. Personal communication.
3. Pickel, C., D.B. Walsh, & N.C. Welch. 1990. Using degree-days to time insecticide sprays for Lygus control. Santa Cruz County Extension Publication.

PNN Update

The Pesticide Notification Network (PNN) is operated by WSU's Pesticide Information Center for the Washington State Commission on Pesticide Registration. The system is designed to distribute pesticide registration and label change information to groups representing Washington's pesticide users. PNN notifications are now available on our web page. To review those sent out in the month two months prior to this issue's date, either access the PNN page via the Pesticide Information Center On-Line (PICOL) Main Page on URL **http://picol.cahe.wsu.edu/** or directly via URL **http://www.pnn.wsu.edu**. We hope that this new electronic format will be useful. Please let us know what you think by submitting comments via e-mail to Jane Thomas at **jmthomas@tricity.wsu.edu**.

Pesticide Stewardship Conference

The National Pesticide Stewardship Alliance (NPSA) will hold its second annual conference November 27 through December 1, 2001, in Memphis, Tennessee. The conference will concentrate on many different aspects of responsible pesticide stewardship. It will provide a dynamic forum for exchanging information, discussing ideas, meeting leaders involved in shaping stewardship policy, and promoting the mission of NPSA. There will be a strong emphasis on interactive sessions; participants will include pesticide waste disposal companies, pesticide manufacturers, IPM educators and researchers, recycling program representatives, and pesticide applicators and consultants. For more information, contact Kathy Brooks at **kbrooks@arrowchase.com** or (877) 920-6772.

CALL FOR PAPERS

If you are intested in presenting a paper or participating in a panel at the conference, submit an abstract up to 100 words by June 30, 2001, to Allan Felsot, **afelsot@tricity.wsu.edu**, (509) 372-7365, FAX (509) 372-7460 or M. L. Robinson, **nlvpalms@juno.com**, (702) 257-5529, FAX (702) 222-3100.

Pesticide Spray Drift Conferences

A Pesticide Spray Drift Conference will be held in Sacramento, California, on September 5 and 6, 2001. This two-day conference targets educators, regulators, industry representatives, and association leaders. It is sponsored by the Spray Drift Task Force, the U. S. Environmental Protection Agency, and the American Association of Pesticide Safety Educators. For more information, go to Internet website **http://pep.wsu.edu/ncodm/conf01.html**.

Another Pesticide Spray Drift Conference is tentatively scheduled for February 2002 in northern Idaho. This conference will replace the the 2001 annual Pacific Northwest Pesticide Issues Conference. It will be a collaborative venture between the Idaho Department of Agriculture and Washington State University and will target pesticide applicators in agriculture, rights of way, and turf and ornamental applications.

Interested parties can contact Carol Ramsay at WSU (**ramsay@wsu.edu**) for more information on either of these conferences.

Tolerance Information

Chemical (type)	Federal Register	Tolerance (ppm)	Commodity (raw)	Time-Limited		
				Yes/No	New/Exte	Expiration Date
ethametsulfuron methyl (herbicide)	4/6/01 pg. 18201	0.02 0.02 0.02	canola crambe rapeseed	No	N/A	N/A
fenpyroximate (insecticide)	4/10/01 pg. 18561	1.00 10.00	wine grapes hops	Yes	New	4/12/04
Comment: This time-limited tolerance was requested as an import tolerance by Nihon Nohyaku.						
imidacloprid (insecticide)	4/10/01 pg. 18554	3.50 0.10 0.20 0.05 0.20 0.10 0.05 1.00 1.00 3.50 6.00	cilantro sweet corn, forage sweet corn, stover sweet corn (K+CWHR) field corn, fodder field corn, forage field corn, grain edible podded beans succulent shelled beans turnip greens leaf petiole vegetable subgroup	No	N/A	N/A
zoxamide (fungicide)	4/11/01 pg. 18725	0.06 0.30 0.10 3.00 15.00	potato, tuber potato, granule/flake potato, wet peel grape grape, raisins	No	N/A	N/A
propiconazole (fungicide)	4/18/01 pg. 19863	12.00 12.00 0.10 0.10	field corn, stover field corn, forage field corn, grain sweet corn (K+CWHR)	Yes	New	3/30/04
Comment: With this action EPA is reestablishing tolerances that expired 12/31/00.						
metolachlor (herbicide)	4/18/01 pg. 19860	0.10 0.30 0.60	tomatoes tomato puree tomato paste	Yes	Extension	6/30/02
metolachlor on tomatoes for control of weeds in Ohio, Pennsylvania, Michigan, Maryland, California, and Virginia.						
hexythiazox (ovicide/miticide)	4/18/01 pg. 19879	1.00 0.30 2.00 0.40 0.10 2.00	caneberry crop subgroup nut, tree, group peppermint, tops plum, prune, dried plum, prune, fresh spearmint, tops	No	N/A	N/A