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Is "Good" Enough?

Proper Time and Place for GLP

Dr. Vincent Hebert, Analytical Chemist, WSU

Good Laboratory Practice (GLP) is a group of standards set forth by the U.S. Environmental Protection Agency (EPA) to insure high quality, consistent data when assessing human and environmental impacts of a pesticide proposed for registration. The need for GLPs arose when a few bad players in the early years of toxicity testing and pesticide registration were found to be recording inconsistent data, keeping incomplete documentation, falsifying data, and engaging in other unethical practices (see "The How and Why of GLP," page 3). In response, EPA implemented regulation 40CFR Part 160, Good Laboratory Practice.

Today, any study intended for submission in support of an application for a pesticide marketing permit must be conducted in accordance with GLP. GLPs help insure study quality by providing a regulatory framework that encompasses all phases of study design, implementation, and documentation. Facilities performing GLP studies must employ staff trained in GLP procedures, must have documented field and analytical procedures in place, and must utilize an independent quality assurance unit (QAU) that inspects and audits critical phases of both field and analytical portions of the study.

GLP at FEQL

One of the primary missions of the Food and Environmental Quality Laboratory (FEQL) at Washington State University (WSU) is to generate data in support of minor crop registrations through the U.S. Department of Agriculture (USDA) Interregional Research Project #4 (IR-4) program. These regulatory evaluations must meet EPA's rigorous GLP standards. Therefore, it is imperative that the FEQL establish a laboratory facility capable of and certified for GLP studies. We have undertaken this considerable task because this work is important to the public we serve.

As a land grant university laboratory, however, we wear many caps. Besides our GLP regulatory science program, the FEQL also conducts original research including product-understanding studies (i.e., how to optimize a pesticide use while minimizing human and ecological hazards though best management practices); worker

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"Good" and GLP, cont.

Dr. Vincent Hebert, Analytical Chemist, WSU

exposure and other hazard assessments; and evaluation of the fate and transport of pesticides and non-agricultural pollutants (e.g., PAHs, PCBs) in the environment. Unlike IR-4 and other regulatory studies, these studies are not usually intended to gain a marketing permit for a pesticide manufacturer. As such, these studies need not follow the documentation rigors of GLP. Just the same, we conduct our science in keeping with the spirit of GLP, with our own stringent internal quality standards and regular internal quality assurance audits. In other words, we use good laboratory practices even when we aren't using Good Laboratory Practice.

Is "Good" Always Best?

As a former industry study director and researcher I have grown to appreciate the value of GLPs for insuring study integrity in an enforceable regulatory framework when the work will be used for marketing pesticides. This is the original intent: a regulatory mechanism for data consistency, international harmony, and protection from fraud for pesticide marketing permit studies.

But GLP has taken on a connotation beyond its regulatory intent. Somewhere along the way, the mystique of the word "good" seems to have led research sponsors to assume "if it ain't 'good,' it must be 'not good.'" Consequently, I've been asked to perform GLP assessments for projects not directed toward pesticide marketing, such as investigating a thorny environmental problem (e.g., air sampling to determine fumigant concentration) or an episodic pollution event (e.g., a chemical spill). This type of work is exploratory in nature, therefore not well suited to predetermined guidelines and rigid protocol. Indeed, such constraints can hamper exploratory research. And conducting a study under GLP standards invariably increases the cost, often substantially.

GLP Unmasked

It is time to unravel the myth that good science and quality cannot be guaranteed unless a study is performed under GLP standards. While GLP protocol is rigorous and necessary for assurance of standardized data (see "The How and Why of GLP," page 3), it does not insure good science. It does insure good data. Well-documented, poor science can conform to GLP standards.

In ***Good Laboratory Practices: An Agrochemical Perspective*** (eds. Willa Garner and Maureen Barge) the point is made:

> "Quality is a highly subjective personal value and because of this, the existence of GLPs alone cannot guarantee that the reported work is scientifically sound. Unless the program addresses science and good record keeping collectively, all GLPs will do is insure that the documentation was done in the lab…[they will not insure] the science or quality of the work."

GLPs can provide a level of assurance, but they do not guarantee good science. Good scientists do good science.

That being said, there is no question of the importance of 40CFR Part 160: GLPs assure study integrity and construction in an enforceable regulatory framework absolutely appropriate for pesticide marketing. But GLPs were not designed for nor intended to address basic exploratory research since this form of scientific inquiry cannot be constrained to a set of predetermined routine guidelines. Acknowledging this, EPA does not require GLPs for biological field evaluations that determine the efficacy of a new pesticide or herbicide. Such studies are regarded as exploratory in nature since many candidate pesticides are screened without clear indication of their future marketing potential.

What's In a Name?

If GLP "gets in the way" of exploratory science, why is it so often requested by sponsoring organizations? Again, a lot can be attributed to semantics. That little word "good" holds a lot of sway. The fact is that, for many academic laboratory and field researchers engaged in making original observations and design-

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Dr. Vincent Hebert, Analytical Chemist, WSU

ing environmentally relevant exploratory research, conducting studies under GLP guidelines is like putting the genie of discovery back into its bottle.

It’s a shame that “good” can be the enemy of “better.” A lot of us would feel better if EPA would rename 40CFR Part 160 something more appropriate than it’s misleading moniker, like “Pesticide Marketing Permit Practices.” That might be “good” for all of us.

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The How and Why of GLP

Since the 1960s, the burden of proof for providing human and environmental safety data to insure our food supply has rested on the shoulders of the pesticide manufacturer. The manufacturer or registrant must conduct a battery of tests and provide a litany of information to the U.S. Environmental Protection Agency (EPA) when marketing a pesticide product.

In the early years, no routine guidelines governed the information registrants packaged for the EPA. As one can imagine, a general lack of conformity existed in data submissions. Many data packages supplied to the EPA poorly and inaccurately described the toxicity and nature of pesticide residues.

There was general agreement that standards were needed. Some contractual laboratories kept incomplete records and others were suspected of unethical practices and even outright falsification of data. Such practices came to light during a 1976 audit conducted by the U.S. Food and Drug Administration (FDA) in a well-publicized case against Industrial Biotest Laboratories, a laboratory that at the time was conducting 35% to 40% of all animal tests in the United States. The FDA responded by implementing stringent guidelines for their clinical trials. The FDA’s investigation also uncovered fraudulent records for a large number of pesticide studies performed by Industrial Biotest Laboratories, triggering the need for an enforcement response from the EPA.

In 1983, the EPA adopted the provisions pioneered by FDA and established detailed guidelines describing how routine pesticide registration requirements (product chemistry, environmental fate/effects, metabolism, toxicity and residue studies) must be performed.

GLPs were made effective in 1989. Shortly thereafter, audits performed by EPA’s Office of Pesticide Programs uncovered two major cases of data fabrication by contractual laboratories. Both of these cases lead to the invalidation of hundreds of pesticide marketing studies and subsequent criminal convictions.

Today, each scientific study submitted for EPA review must take place at a laboratory facility that has been certified as capable of conducting studies under GLP regulations. Such facilities assign specially trained personnel, construct a detailed protocol, implement standard operating procedures, and maintain quality assurance oversight through a quality assurance/quality control unit that conducts internal audits of raw data and laboratory practices. Once the EPA receives the data from a GLP lab, scientists representing appropriate disciplines thoroughly review it, looking not only at the substantive results, but also for signs that the data may not be trustworthy (e.g., internal inconsistencies, discrepancies with tests run on similar products, or missing information on GLP compliance). Quality is further assured through site audits conducted on regular basis by the EPA. The EPA is empowered to take regulatory and civil action against potential submissions of fraudulent data and GLP violators.

Clearly, the rigors of GLP regulations are necessary within the context for which they were designed. Equally clearly, the consequences of a few parties’ illegal activities have had far-reaching effects on an otherwise highly professional and ethical industry.

Keeping Fruit Trees Virus-Free

NRSP5's Role in Tree Fruit Production

Dr. Ken Eastwell, Plant Pathologist and Director of NRSP5

Most agricultural crops are susceptible to infection by viruses. The results of virus infection are highly variable, depending on the crop, the virus involved, and the timing of the infection. In the case of annual field crops, the plants are harvested at the end of the growing season and any virus-infected plants are removed in the process. The field is then renewed with virus-free seedlings the following year.

Viruses in Fruit Trees

However, fruit trees present a special challenge for virus control. Commercial varieties of fruit tree do not breed "true-to-type." That is, when seed from a tree with desirable characteristics is collected and allowed to germinate, it will not necessarily yield seedlings with the characteristics of the parent tree. In fact, most fruit trees grown from seed will not yield marketable fruit. Because of this, trees are propagated by grafting buds from a tree with desired characteristics onto a rootstock.

TABLE 1	
Number of Accessions* Released by NRSP5 from 1990 to 2000	
Malus spp.:	
apple	473
pear	79
Prunus spp.:	
cherry	251
peach	251
plum	114
nectarine	71
apricot	65
(*Different varieties or clones)	

As trees grow in the orchard season after season, they are constantly at risk of becoming infected with a virus. Once a tree becomes infected, the plant has no ability to eliminate the virus from its tissues so the tree remains infected. Most new trees propagated from buds of a virus-infected tree will also be virus-infected. Furthermore, rootstocks themselves can carry viruses that can be transmitted to the grafted variety. Thus, as trees are propagated generation after generation, they accumulate all of the viruses with which their progenitors had become infected. Some viruses quickly kill or weaken the trees; these are rapidly eliminated from the propagation cycle. However, many viruses do not induce symptoms that are easily recognized. These same viruses rob the grower by decreasing fruit yield or degrading fruit quality, thus reducing the profitability of the orchard operation season after season. Other viruses do not cause severe symptoms until trees are mature and bearing fruit. History has taught us that one of the best strategies to stop this spiral of ever-increasing virus infection and decreasing yields is to develop and use virus-free trees for orchard planting.

NRSP5's Role

The National Research Support Project Number 5 (NRSP5) provides the greater fruit tree community with virus-tested propagation material for fruit and nursery stock production, for research, and for virus detection programs. The efforts of NRSP5, in conjunction with Federal virus quarantine and state certification programs, provide the primary mechanisms by which virus diseases of deciduous fruit trees are controlled in the United States.

NRSP5 is a multi-state-funded research support project located at Washington State University's Irrigated Agriculture Research and Extension Center (IAREC) in Prosser. In 1955, the Interregional Research Project #2 (IR-2) was established using Federal dollars designated for research at land grant universities. The program was created to serve as a source of virus-tested propagation material representing standard cultivars and new selections from public breeding programs. Today, the project is known as NRSP5, has expanded in scope, and continues to derive a portion of its funding from the Federal government.

Program Evolution

NRSP5 has evolved with the changing needs of the agricultural community. For example, NRSP5 provides many of the virus-free trees required by breeders and horticulturists. Since viral infections impose changes in growth and yield characteristics, virus-free trees are necessary for reliable assessment of fruit tree clones. Originally, the program provided such material directly to the researchers. Today, NRSP5

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NRSP5, Fruit Trees, cont.

Dr. Ken Eastwell, Plant Pathologist and Director of NRSP5

produces many virus-tested clones that become the basis of certification programs throughout the United States. These trees are in turn available to researchers from nurseries that distribute certified virus-tested trees.

Just as the relationship with researchers has changed, so has the role of NRSP5 in relation to the fruit production and nursery industries. In 1988, NRSP5 obtained a permit from the United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) that allows the program to accept propagation material directly from international sources. Today, the program provides a hub for the safe exchange of new fruit tree cultivars from around the world. This activity insures that our industry has access to the latest and most promising tree fruit varieties in the world.

Research, Diagnosis, Treatment

The preventative measures provided by NRSP5 avert many virus-associated disease problems of fruit trees, problems that affect the grower and the consumer alike. Rapid and reliable diagnostic methods are key to this control strategy. Disease testing time has decreased dramatically, from an average of five years for full virus testing a decade ago to one and a half years today. In some cases, virus-tested material is available for propagation in as little as eight months.

To help insure continued improvement and an appropriate level of service to our nation's tree fruit industry, NRSP5 is engaged in both independent and cooperative research programs. Basic and applied research leads to characterization of viruses and virus-like agents that infect fruit trees and to improvements in pathogen detection. NRSP5 fosters cooperation with research groups to increase the reliability of the assays and to hasten the safe passage of material through the virus screening process.

Once viruses are detected in a fruit tree clone or variety that is of interest to the industry, the viruses must be eliminated before propagation materials (buds) are released for distribution. NRSP5 continues to investigate potential improvements to techniques such as heat and chemical treatment commonly used to eliminate viruses from propagation material. These techniques must be generalized to accommodate the large variety of species and clones that are encountered each year.

NRSP5 Today

NRSP5 consolidates many fruit tree virus activities in one location, providing a focal point for disease control. A recent collaboration with ***Prunus*** breeders and horticulturists, for example, resulted in identifying rootstocks that are particularly sensitive to viruses that commonly infect orchards in cherry production areas of the world; these sensitive rootstocks were then eliminated from further consideration early in rootstock evaluation trials. Our Prosser center provides information about the safe movement of fruit tree propagation material and about some of the disorders that can affect these trees. We maintain a network of experts who aid in virus disease management at the orchard level, offering assistance in disease diagnosis and determination of disease epidemiology. NRSP5's program and services are summarized on the Internet at URL **http://www.nrsp5.prosser.wsu.edu**.

Just as the fruit tree industry has evolved during an era of heightened awareness of breeders' rights, NRSP5 has also evolved. Programs have been developed and modified to accommodate the growing need for cultivars from foreign sources and for cultivars protected by proprietary rights. Today's tree fruit industry relies extensively on the NRSP5 program, attesting to its success. Since 1990, 1,344 virus-tested fruit tree selections have been released and distributed by NRSP5. These represent an important and diverse group of fruit trees that will provide future opportunities for the orchard industry and for the American consumer.

Dr. Ken Eastwell is a Virologist and Plant Pathologist with Washington State University. He directs the NRSP5 program and can be reached in Prosser at (509) 786-9385 or at keastw@tricity.wsu.edu.

IR-4 Projects

Input Needed Now for 2002

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Last month, I listed the new herbicide and insecticide projects initiated by the Interregional Research Project Number 4 (IR-4) in 2001. This month, I present the lists of fungicides and nematicides.

Background

IR-4 was established in 1963 to increase the availability of crop protection chemistries for minor crop producers. IR-4 is a federal/state/private cooperative that aspires to obtain clearances for pest control chemistries on minor crops. (For a description of IR-4's workings see "IR-4: Developing and Delivering Pest Management Solutions for Minor Crop Producers," ***AENews*** No. 162, Oct. 1999, or log onto the IR-4 national website at **http://pestdata.ncsu.edu/ir-4/**).

The Food Quality Protection Act (FQPA) of 1996 changed the landscape of food safety and pesticide use. We are now in year five of the FQPA era. Revised risk assessments of pesticides—for better or worse—are being ground through the regulatory system. In many cases, pesticide uses are being curtailed or dramatically restricted. As the U.S. Environmental Protection Agency restricts the use of key pesticides, registration of alternative products becomes even more important.

Projects Currently Underway

Each year, dozens of new projects are undertaken by IR-4. The new herbicide and insecticide projects initiated in 2001 were listed in the July issue of ***AE-News,*** and the fungicides and nematicides are shown in the tables beginning below. Past IR-4 projects, many of which are still in progress, can be found through the ***AENews*** website at **http://www2.tricity.wsu.edu/aenews/April00AENews/NewProducts.html**. Remember that crop registrations listed in the table below may not apply to Washington State; please consult the label.

Fungicide	Trade Name	Registration
AC382042		Pending registration on rice.
Acibenzolar	Actigard	Potential and pending registration on most commercially grown vegetable crops.
Agriphage		Pending registration on tomato.
Ampelomyces quisqualis isolate M-10	AQ 10	Pending registration on all commodities.
Aspergillus flavus AF 36		Pending registration on cotton.
Azoxystrobin	Heritage, Quadris, Abound	Registered on almond, apricot, balsam apple and balsam pear, beech nut, bittermelon, Brazil nut, butternut, canola, cashew, cherry, cucumber, gourd, grape, macadamia nut, melons, nectarine, peach, peanut, pecan, squash, wheat, and rice. Pending and potential registration on a very wide range of agricultural crops.
Bacillus subtillis	Serenade	Pending use on grapes, and pome fruit. Potential uses on other tree fruits and vegetables.
Burkholderia cassia	Leone	Potential use on potato, tomato, strawberry, and grapes.
Burkholderia cepacia	Blue Circle	Registered on bean, cabbage, corn, field crops, fruit trees, fruiting vegetables, pea, root vegetables, small grains, squash, tomato and grapes.
Bacteriophages	AgriPhage	Registration pending on pepper and tomato.

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IR-4 Projects, cont.

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Prioritization Workshop in September

Each year, IR-4 receives a far greater number of requests than the program can pursue, so projects are prioritized, and only the higher-priority projects are guaranteed investigation. The prioritization process takes place at an annual meeting. The IR-4 prioritization workshop for year 2002 projects will take place in Colorado, September 11 through 13, 2001.

Your Participation is Encouraged

As the Washington State Liaison to the IR-4 program and as a Commissioner on the Washington State Commission on Pesticide Registration, I need to know the pest control needs and concerns among the diverse agricultural producers of Washington State.

Submit a PCR Form

The first step toward making a pesticide need known is to submit a Pesticide Clearance Request form (PCR) to IR-4. Anyone can submit a PCR; parties in Washington State can obtain them from me. I can assist interested parties in prompt submission of the form and I can help bring those needs to the attention of IR-4 at the September meeting.

Individuals or groups wishing to initiate review of a particular crop-chemistry combination should contact me right away. Washington State has a strong reputation for being proactive in pest control efforts. This is facilitated through communication between agricultural producers and university specialists. Please make your pest control needs and concerns known to me so that I can make your voice heard in Colorado.

Dr. Douglas B. Walsh is the Washington State Liaison Representative for IR-4. His office is located at WSU's IAREC facility in Prosser. He can be reached at dwalsh @tricity.wsu.edu or (509) 786-2226.

Registrant	Mode of Action	Activity
BASF	Phenoxyamide	Systemic protectant fungicide for control of rice blast.
Syngenta	Benzothiadiazole (systemic acquired resistance inducer)	Induces resistance to blue mold, bacterial diseases, downy mildew, and ***Sclerotinia.*** Reduced risk pesticide.
AgriPhi, Inc.	Bacteriophage	Controls bacterial speck of tomato and bacterial black spot of both tomato and pepper.
Ecogen	Biopesticide	Hyperparasite of powdery mildew.
USDA	Biopesticide	Competitive inhibition of aflatoxin. Production by natural ***Aspergillus*** strain.
Syngenta		Broad spectrum of pathogens of fungi. Reduced risk pesticide.
AgraQuest	Biopesticide	Manages ***Phytophthora, Alternaria,*** and other pathogens.
Valent	Biopesticide	Control of soilborne and foliar diseases.
Stine Microbial Products	Biopesticide	Control of damping-off ***(Fusarium, Pythium, Phytophthora).***
Agriophi	Biopesticide	Manages bacterial diseases, specifically bacterial spot and bacterial speck.

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IR-4 Projects, cont.

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Fungicide	Trade Name	Registration
BAS 500	Headline	Pending and potential registration on a wide variety of crops
BAS 510		Not disclosed.
BAS 516		Not disclosed.
Candida oleophila		Potential to be registered on pome and stone fruit, citrus, plum, and quince.
Chitosan		Not disclosed.
Cinnamaldehyde	Cinnacure, Cinnamite	Not disclosed.
Coniothyrium minitans	Contans	Registered on most agricultural commodities.
Copper octanoate	NEU-1140F	Registered on various bean varieties, beet, broccoli, carrot, corn, cucumber, eggplant, grape, hops, kale, kohlrabi, leek, peas, pepper, squash, strawberry, spinach, sunflower, strawberry, and turnip.
Cyamidazo-sulfamid	IKF-916	Potential registration on pear and apple balsam, cabbage, cucumber, gourd, grape, lettuce, onion, potato, various squash, tomato, and watermelon.
Cymoxanil	Curzate	Registered on potato and tomato. Pending registration on hops.
Cyproconazole	Alto	Registered on coffee.
Cyprodinil	Vangard	Registered on several fruit and nut tree crops. Pending registration on onion, strawberry, pistachio, blueberry, and watercress.
Cyprodinil/ Fludioxonil	Switch	Potential registration on basil, broccoli, Brussels sprouts, cabbage, caneberry, carrot, cauliflower, chive, greens, garlic, kale, lychee, grape, mizuna, spinach, onion, pear, shallot, and strawberry.
Difenoconazole	Dividend	Registered on banana, barley, rye, and wheat. Pending registration on canola and sweet corn.
Dimethomorph	Acrobat	Registered on potato. Pending registration on a wide variety of vegetable crops.
Dithianon	Delan	Pending registration on apple, crabapple, hops, loquat, mayhaw, pear, and quince.
Epoxyiconazole	Opus	Not disclosed.

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IR-4 Projects, cont.

New Fungicide Listing, pp. 6–17; New Nematicide Listing, pp. 16–19.

Registrant	Mode of Action	Activity
BASF	Strobilurin (mitochondrial electron transport inhibitor)	Control of damping-off (***Fusarium, Pythium, Phytophthora***).
	Not Disclosed	
BASF	Not Disclosed	Broad-spectrum activity on anthracnose, ***Alternaria,*** downy mildew, powdery mildew, ***Botrytis, Sclerotinia,*** and ***Monilinia.***
	Biopesticide	Active on post-harvest diseases.
	Biopesticide Carbohydrate (chitin-based product, plant defense booster)	
	Cinnamaldehyde (natural product)	
Prophyta	Biopesticide	Controls ***Sclerotinia.***
W. Neudorff	Copper octanoate	Active against downy mildew, powdery mildew, blue mold, white rust, and anthracnose.
BASF	Cyanoimidazole	Effective against oomycete and plasmodiophoromycete fungi.
DuPont	Acetamide	Effective against downy mildew, late blight, ***Phytophthora, Plasmopara, Pseudoperonospora, Bremia,*** and ***Peronospora.*** Should be mixed with other fungicides for resistance management.
Syngenta	Triazole	Active against coffee rust.
Syngenta	Anilinopyrimidine	Ascomycetes and deuteromycetes such as ***Botrytis, Alternaria, Monilinia, Venturia, Pseudocerosporella, Pyrenophora, Septoria, Erisyphe, Rhynchosporium, Glomerella, Coccomyces,*** and ***Colletotrichum***.
Syngenta	Anilinopyrimidine and Phenylpyrrole	Controls ***Botrytis, Alternaria,*** and brown rot. Reduced risk pesticide.
Syngenta	Triazole	Effective against smuts, bunts, ***Aspergillis, Fusarium, Penicillium, Septoria, Cochliobolus, Pyrenophora, Pseudocercosporella***, and ***Gaeumannomyces.***
BASF	Cinnamic acid derivative	Effective against downy mildew, late blight, ***Phytophthora, Plasmopara, Pseudoperonospora, Bremia,*** and ***Peronospora.*** Should be mixed with other fungicides for resistance management.
BASF	Nitrile	Controls scab, downy mildew, rust, and leaf spot.

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IR-4 Projects, cont.

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Fungicide	Trade Name	Registration
Elexa	Greenleaf	Potential use on cucumbers, strawberry and grapes.
Ethaboxam	Guardian	Potential registration on a wide variety of fruit and vegetable crops.
Famoxadone	Famoxadate	Pending and potential registration on amaranth, arugula, balsam apple and pear, barley, bittermelon, buckwheat, cardoon, celery, celtuce, chayote, chervil, celery, cucumber, waxgourd, chrysanthemum, citron melon, corn, cress, dock, eggplant, endive, fennel, gherkin, grape, groundcherry, hops, lettuce, millet, muskmelon, and oats.
Famoxate	Tanos	Pending registration on balsam apple, balsam pear, various melons cucumbers, lettuce, tomato, onion, and squash.
Fenamidone	Reason	Potential on a wide variety of fruit and vegetable row crops.
Fenbuconazole	Indar, Enable	Registered on apricot, banana, cherry, nectarine, pecan, and plumcot. Pending registration on blueberry, cranberry, pepper, and grapefruit.
Fenhexamid	Elevate	Currently registered on several tree and vine crops. Potential registration on other fruit and vegetable crops.
Fenpropimorph		Pending registration on banana. Currently registered on barley, sugar beet, and several grain crops.
Fluazinam	Omega	Pending registration on several fruit and vegetable crops.
Fludioxonil	Maxium, Scholar	Registered on a variety of beans, beets, broccoli, cabbage, peas, cucumbers, grains, greens, radish, squash, melons, yams, plus other vegetables. Pending registration on nectarine, plum, peach, apple, and apricot.
Fluquinconazole	Jockey, Castellan	Registered on cereal grains.
Flutolanil	Moncut	Registered on peanut and rice. Pending registration on potato.
Fosetyl-AL	Aliette	Registered on many agricultural crops. Pending registration on cranberry, lingonberry, leek, pea, raspberry, and turnip.
Gliocladium catenulatum Strain J1446	Prestop	Registered on pome and stone fruit, balsam pear and apple, broccoli, cabbage, cardoon, cauliflower, celery, chayote, cucumber, chrysanthemum, dandelion, dock, eggplant, fennel, gherkin, gourd, groundcherry, kale, kohlrabi, lettuce, greens, rhubarb, spinach, squash, tomato, and melon.
Harpin Protein	Messenger	Registered on stone fruit, pome fruit, grain, citrus, melon, ornamentals, pepper, potato, squash, raspberry, soybean, strawberry, sugarcane, tobacco, and turf.

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IR-4 Projects, cont.

New Fungicide Listing, pp. 6–17; New Nematicide Listing, pp. 16–19.

Registrant	Mode of Action	Activity
Safe Science	Biopesticide	Manages downy and powdery mildew, potato and tomato blight, and pepper blight.
LG Chemicals	Thiazole carboxamide	Useful for grape downy mildew, potato and tomato late blight, pepper blight, and cucumber downy mildew. Preventative and curative activity.
DuPont	Oxazolidinedione	Broad-spectrum fungicide controls early blight, downy mildews, and other ascomycetes. Can be combined with Cymoxanil (Tanos) to pick up late blight. Candidate reduced risk pesticide.
DuPont	Famosadone	Broad-spectrum fungicide controls early and late blight.
Aventis	Imidazolinone	Foliar protectant and curative against oomycete fungi. Also effective against ascomycetes, ***Alternaria,*** late blight, and downy mildew. Inhibits electronic transport. Candidate reduced risk pesticide.
Rohm and Haas	Triazole	Powdery mildew, rusts, apple scab, brown rot, cotton ball, mummy berry ***(Monilinia*** spp.), smuts, bunts, ***Cladosporium, Mycosphaerella, Cercospora, Septoria, Rhizoctonia, Pyrenophora, Helminthosporium*** and related genera, and ***Colletotrichum*** in turf.
Tomen-Agro	Hydroxyanilide	Non-systemic protectant fungicide that is effective against ***Botrytis cinerea, Monilinia,*** and ***Sclerotina sclerotiorum*** of lettuce.
BASF	Morpholine	For powdery mildew, rust, ***Helminthosporium, Rhyncosporium,*** and ***Septoria*** spp. in cereals; ***Cercospora*** and ***Erysiphe*** in sugar beets.
Syngenta, ISK	Pyridinamine	Broad-spectrum disease control: ***Alternaria, Botrytis, Cladosporium, Collectotrichum, Phytophthora, Plasmopara, Rhizoctonia, Sclerotinia, Venturia,*** and ***Streptomyces;*** also controls some mites.
Syngenta	Phenylpyrrole	Effective against ***Fusarium, Helminthosporium, Rhizoctonia, Aspergillus, Alternaria, Ascochyta, Tilletia, Sclerotinia,*** and ***Septoria.***
Aventis	Triazole	Controls take-all, rust, and a wide range of ascomycetes in cereals.
Gowan, Nihon Nohyku	Benzamide	Controls rusts, sheath blight, damping off, and other diseases caused by ***Rhizoctonia*** and ***Verticillium.***
Aventis	Aluminum Phosphate	Controls ***Phytophthora, Alternaria,*** and downy mildew.
Kemira Agro	Biopesticide	Recommended for control of ***Pythium*** and ***Rhyzoctonia.***
Eden Bioscience	Protein that switches natural plant defenses in the plant.	Controls bacterial leaf spot, bacterial wilt, bacteria blight, and certain fungal diseases. Biopesticide. Methyl bromide replacement.

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IR-4 Projects, cont.

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Fungicide	Trade Name	Registration
Hexaconazole	Proseed	Registered on barley and wheat.
Hydrogen peroxide	Oxidate	Pending registration on pome and stone fruit, beans, cabbage, cauliflower, citrus, greens, spinach, pepper, squash, and tomato.
Hymexazol		Registered on sugar beet. Potential registration on dry and succulent peas.
Imazalil	Fungaflor 500 EC	Potential registration on calamondin, citrus fruit, and kumquat.
Imicadione	Bellkute, TM 417	Potential registration on tree fruit and nuts.
Iprovalicarb	Melody	Potential registration on avocado, calamondin, citrus citron, citrus hybrids, cucumber, grape, grapefruit, kumquat, lemon, lettuce, lime, tangerine, oranges, potato, pummelo, mandarin, and tomato.
Kresoxim-methyl	Sovran, Cygnus	Registered on crabapple, apple, grape, loquat, pear, pecan, and quince. Pending registration on apple and pear balsam, cucumber, grains, corn, potato, squash, teosinte, triticale, and melon.
Mefenoxam	Ridomil Gold	Registered on many crops including, but not limited to: alfalfa, almond, apple, apricot, beans, broccoli, buckwheat, cabbage, canola, carrot, catnip, cucumbers, chervil, chive, clover, corn, cranberry, cress, spices, spinach, stone fruit, grains, citrus fruit, radish, salsify, and yams.
Mepanipyrim	Frupica	Registered on grapes.
Milsana bioprotectant		Pending registration on apple, balsam apple, balsam pear, melons, strawberry, squash, gherkin, cucumber, chayote, and grape.
MON 65500		Pending registration on wheat.
Myclobutanil	Rally, Nova	Registered on almond, apple, apricot, grape, peach, plum, and prune. Pending registration on melons, artichoke, asparagus, beans, cucumber, currant, eggplant, gherkin, gooseberry, hops, lettuce, mint, pear, and pepper.
Pantoea Agglomerans C9-1		Pending registration on apple and pear.
Peroxyacetic acid		Registered on a wide variety of tree fruit, nuts, grain, herbs, melon, vegetables, seeds, wintergreen, woodruff, and wormwood.
Phosphonic acid	Foli-R-Fos	Potential registration on many crops including, but not limited to: pome fruit, asparagus, balsam apple and pear, broccoli, cabbage, celery, chrysanthemum, citrus, cress, several herbs, hops, spinach, pineapple, greens, squash, strawberry, tomato, and watermelon.
Phosphorous acid	Agri Phos	Pending registration on a wide variety of crops, including: vegetables, pome fruit, grape, gourd, lettuce, citrus, purslane spinach, greens, squash, strawberry, tomato, and watermelon.
Picoxystrobin	ZA 1963	Potential registration on apple, barley, buckwheat, corn, millet, oats, popcorn, rice, rye, sorghum, teosinte, triticale, wheat, and wild rice.
Potassium bicarbonate	Kaligreen & Armicarb	Potential registration on all commodities.

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IR-4 Projects, cont.

New Fungicide Listing, pp. 6–17; New Nematicide Listing, pp. 16–19.

Registrant	Mode of Action	Activity
Syngenta, ISK	Triazole	Controls loose smut and common root rot via seed treatment.
Bio Safe Systems	Hydrogen peroxide	Broad-spectrum bactericide and fungicide.
Sankyo	Azole	Controls seed rot, ***Aphanomyces.***
Janssen-Cilag	Not disclosed	Post-harvest control of blue and green mold.
Tomen Agro	Not disclosed	Post-harvest control of ***Penicillium*** and ***Geotrichum.*** New chemistry, good for resistance management.
Bayer	Amino-acid amide carbamate	Activity on oomycete fungi, downy mildew, and ***Phytophthora.***
BASF	Strobilurin	Effective against mildews, ***Septoria,*** rusts, scab, ***Phomopsis,*** and black rot. Provides protectant, curative, and eradicant control of powdery mildew.
Syngenta, Nufarm	Active isomer of metalaxyl	Same spectrum as metalaxyl.
Kumiai Chemical	Anilinopyrimidine	Controls ***Botrytis.***
KHH Bioscience	Biopesticide (extract from giant knotweed)	Induces phytoalexins which confer resistance to powdery mildew and other diseases such as ***Botrytis.***
Monsanto	Not disclosed	Control of take-all (***Gaeumannomyces graminis).***
Rohm and Haas	Triazole	Powdery mildew, rusts, apple scab, brown rot, shothole, cherry leaf spot, and grape black rot.
Plant Health Tech.		Active against fireblight.
Ecolab	Peroxyacetic acid	Active against post-harvest decay and rot.
Wilbur-Ellis	Phosphonic acid	Effective against downy mildew.
Agtrol Int.	Phosphoric acid	
	Second-generation strobilurin	
Toagosei, Church & Dwight	Biopesticide	Effective against powdery mildew.

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IR-4 Projects, cont.

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Fungicide	Trade Name	Registration
Potassium dihydrogen phosphate	eksPunge	Registered on apple, cherry, cucumber, grape, mango, melon, nectarine, peach, pepper, plum, squash, tomato, and watermelon.
Propamocarb hydrochloride	Previcarb	Pending registration on balsam apple and pear, bittermelon, chayote, cucumber, citron melon, gherkin, gourd, lettuce, muskmelon, pepper, potato, pumpkin, and squash. Potential registration on sugar beet, calamondin, carrot, celery, eggplant, grapefruit, groundcherry, kumquat, lemon, lime, orange, pepino, plummelo, spinach, and tomatillo.
Propiconazole	Tilt/Orbit	Registered on barley, buckwheat, celery, corn, grass seed, millet, peanut, pineapple, popcorn, rice, rye, sugarcane, teosinte, wheat, and wild rice. Pending registration on almond, dry bean, beech nut, blueberry, Brazil nut, butternut, carrot, cashew, chestnut, chinquapin, filbert, grain sorghum, hickory nut, macadamia nut, mint, onion, pecan, raspberry, soybean, and black walnut. Potential registration on turnip, artichoke, beet, blackberry, and parsley.
Pseudomonas chloroaphis strain 63-28	AtEze	Potential registration on cucumber, pepper, and tomato.
Pseudomonas fluorescens PRA-25		Registered on snap bean, sweet corn, and pea.
Pseudomonas syringae	BioSave	Registered on turf.
Pseudozyma flocculosa	Sporadex	
Pyraclostrobin	Headline/ Cabrio	Not disclosed.
Pyrimethanil	Scala	Potential on apple, bean, calamondin, caneberry, citrus, crabapple, cucumber, grape, grapefruit, kumquat, lemon, lime, loquat, mandarin, mayhaw, onion, orange, pea, potato, quince, strawberry, and tomato.
QST 713 (strain of ***Bacillus subtilis)***	Serenade	Registration pending on apple and pear. Potential registration on almond, amaranth, apricot, arugula, balsam apple and pear, beech nut, bittermelon, Brazil nut, broccoli, Brussels sprouts, butternut, cabbage, calamondin, cardoon, cashew, cauliflower, celery, chrysanthemum, melon, cucumber, kumquat, lime loquat, greens ornamentals, parsley, pecan, plum, potato, spinach, strawberry, Swiss chard, tomatillo, walnut, and watermelon.
Quinoxyfen/ DE795		Potential registration on apricot, balsam apple and pear, barley, bittermelon, buckwheat, chayote, cherry, cucumber, corn, eggplant, grain, plum, pepper, popcorn, rye, rice, sorghum, squash, tomato, watermelon, wheat, and wild rice. Pending registration on grape and hops.
Silthiophan	Latitude	Pending registration on wheat and barley.
Spiroxamine	Proper, Hogger, Impulse	Registration pending on barley, grape, oats, and wheat.
Streptomyces lydicus WYEC 108	Actinovate, Actino-Iron	Not disclosed.

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IR-4 Projects, cont.

New Fungicide Listing, pp. 6–17; New Nematicide Listing, pp. 16–19.

Registrant	Mode of Action	Activity
Lido Chemical	Potassium dihydrogen phosphate	Effective against powdery mildew.
	Carbamate	
Syngenta	Triazole	Powdery mildew, rusts, smuts, ***Pyrenophora, Septoria, Cercospora, Cercosporidium, Ascochyta, Pseudocercosporella, Mycosphaerella, Fusicladium, Gaeumannomyces, Monilinia, Clasterosporium, Helminthosporium*** and related genera, ***Kabatiella, Ceratocystis, Sclerotium, Rhizoctonia,*** and ***Rhizopus.***
Agrium	Biopesticide	Target pests include soilborne diseases, ***Rhizoctonia solani,*** and ***Pythium*** spp. Out-competes phytopathogenic species.
Good Bugs Inc.	Biopesticide	Controls pythium seed rot and damping off.
Eco Science	Biopesticide	Controls ***Fusarium.***
Plant Products Ltd.	Biopesticide	Controls powdery mildew.
BASF	Strobilurin (mitochondrial electron transport inhibitor)	Broad spectrum activity on anthracnose, ***Alternaria,*** downy mildew, Cercospora leaf spot, rust, powdery mildew, ***Septoria, Phytophthora,*** Pythium, and ***Rhizoctonia.*** Reduced risk pesticide.
Aventis	Anilinopyrimidine	Active against ***Botrytis*** spp., ***Venturia*** spp., ***Alternaria solani, Alternaria mali, Sphaerotheca macularis*** and ***Monilinia*** spp.
AgraQuest		Protectant fungicide/bactericide, with SAR activity. Broad spectrum. Controls ***Botrytis,*** powdery and downy mildews, early blight, and bacterial spot.
Dow	Quinoline (disrupts early cell signaling activities)	Has shown activity against powdery mildew in a wide range of crops. Candidate reduced risk pesticide.
Monsanto	Carboxamide	Control of take-all ***(Gaeumannomyces graminis)*** via seed treatment.
Bayer	Morpholine	Effective against powdery mildew, most rusts, Rhynchosporium leaf blotch. Chemical shows protective, curative, and eradicative effects.
Natural Industries	Biopesticide	Controls soilborne plant roots and damping off fungi.

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IR-4 Projects, cont.

Dr. Douglas Walsh, State Liaison Representative, USDA/IR-4 Project

Fungicide	Trade Name	Registration
Tebuconazole	Folicur, Elite, Raxil	Registered on banana, cherry, grape, grass seed, and nectarine. Pending or potential use on almond, apple, asparagus, balsam apple and pear, barley, dry and succulent beans, beech nut, sugar beet, bittermelon, Brazil nut, butternut, cashew, chayote, chestnut, cucumber, waxgourd, chinquapin, citron melon, coffee, crabapple, filbert, garlic, gherkin, gourd, hickory nut, hops, loquat, lychee, macadamia nut, mango, mayhaw, muskmelon, mustard greens, okra, pear, pecan, pistachio, plum, pumpkin, quince, squash, sunflower, sweet potato, turnip greens and roots, walnuts, watermelon, and wheat.
Tetraconazole	Eminent 125SL, TM 415	Registration is pending for use on sugar beet and peanut.
Thifluzamid	RH-0753	This product is being considered for registration on peanut and rice.
TM 210		Potential registration on a wide variety of fruit and vegetable crops.
TM 415		Potential registration on a wide variety of crops.
TM 417	Bellkute	Potential use on pre- and post-harvest stone fruit.
Tolylfluanid	Euparen Multi	This product is being considered for registration on apple, grapes, and hops.
Trichoderma harzianum T-39	Trichodex	Pending registration on grape and strawberry.
Trifloxystrobin	Flint, Stratego* (*mix with propiconazole)	Registered on apple, balsam apple and pear, banana, bittermelon, chayote, Chinese cucumber and waxgourd, citron melon, crabapple, cucumber, gherkin, gourd, grape, loquat, mayhaw, muskmelon, peanut, pear, pumpkin, quince, squash, and watermelon. Pending registration on almond, apricot, sugar beet, calamondin, carrot, celery, cherry,citrus citron, eggplant, grapefruit, grass seed, groundcherry, hops, kumquat, lemon, lime, tangerine, nectarine, orange, peach, pepino, pepper, plum, plumcot, potato, prune, pummelo, mandarin, squash, tomatillo, tomato, and wheat.
Triflumizole	Procure, Terraguard	Registered on apple, grape, and pear.
Zoxamide	Gavel	Pending registration on balsam apple and pear, bittermelon, chayote, cucumber, waxgourd, eggplant, grape, groundcherry, muskmelon, pepino, pepper, potato, pumpkin, squash, spinach, tomatillo, tomato, and watermelon.

Nematicide	Trade Name	Registration
	PlantPro	Not available. Being evaluated as part of IR-4's Methyl Bromide Alternative Program.
Benzaldehyde		Not available.
Dazomet	Basamid	Being evaluated as part of IR-4's Methyl Bromide Alternative Program in strawberry and tomato.
Myrothecium verrucaria strain AARC-0255	DiTera	Registered on citrus, broccoli, cabbage, cauliflower, Brussels sprouts, and grapes. Being evaluated as part of IR-4's Methyl Bromide Alternative Program in strawberry and tomato.

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IR-4 Projects, cont.

New Fungicide Listing, pp. 6–17; New Nematicide Listing, pp. 16–19.

Registrant	Mode of Action	Activity
Bayer	Triazole	Powdery mildew, rusts, smuts, bunts, apple scab, ***Pyrenophora, Septoria, Monilinia, Cercospora, Cercosporidium, Ceratocystis, Guignardia, Sclerotium, Rhizoctonia, Coccomyces, Rhynchosporium, Colletotrichum, Botrytis,*** and ***Rhizopus.***
Sipcam Agro, Tomen Agro	Triazole	Controls Cercospora leaf spot, powdery mildew, leafspots, rusts, web blotch, and others. New chemistry, good for resistance management.
Rohm & Haas	Thiazole-carbomanilide (inhibits succinic acid metabolism in fungi)	***Sclerotinia*** and ***Rhizoctonia.***
Tomen Agro	Not Disclosed	***Peronospora*** and ***Phytophthora*** activity. No activity on ***Pythium.*** Reduced-risk pesticide.
Tomen Agro	Not Disclosed	Broad spectrum foliar and post-harvest activity on ascomycetes and basidiomycetes. New chemistry, good for resistance management.
Tomen Agro	Imicadione	Post-harvest control of ***Penicillium*** and ***Geotrichium.***
Bayer	Sulfenamide	Broad-spectrum contact fungicide with good acaricidal effectiveness. Particularly suitable for control of resistant pathogen populations.
Makhteshim-Agan	Biopesticide	This product is effective against ***Botrytis.***
Syngenta	Strobilurin	Active against powdery mildew and leaf spot diseases. Also provides significant control of scab, rusts, downy mildew, and other diseases. Reduced-risk chemistry.
Uniroyal	Triazole	Manages powdery mildews, rusts, apple scab, ***Rhizoctonia, Cylindrocladium, Thielaviopsis, Myrothecium, Alternaria, Helminthosporium*** and related genera.
Rohm & Haas	Amide (Inhibits mitosis by binding to fungal tubulin proteins)	Control of foliar phycomycetes and albugo. Also protectant against oomycete fungi. Will be mixed with mancozeb for greater broad spectrum activity. Reduced-risk pesticide.

Registrant	Mode of Action/Pesticide Activity
	Iodine complex. Controls many pests controlled by methyl bromide. Partial alternative.
BASF	Thiadiazine. Similar to metam sodium. Partial methyl bromide alternative.
Valent BioScience	Biopesticide. Partial methyl bromide alternative. Controls root knot, cyst, lesion, stubby root, pin, reniform, dagger, sting, ring, stunt, lance, spiral, burrowing, and other plant parasitic nematodes.

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An Interesting Conundrum

24c Protects Washington Apples

Dr. Catherine H. Daniels, Pesticide Coordinator, WSU

We have an interesting problem here in the nation's leading apple state. Apple maggot, an important pest of apples, is well controlled in our commercial orchards but not in backyard apple trees. And Washingtonians, who are justifiably proud of their apples, have a lot of backyards.

Backyard apple trees throughout the state continue to serve as little islands of infestation, safe havens for pest insects including apple maggot. When a number of infested trees are spaced over a distance, they can serve as a corridor of infestation from one orchard to another. This situation forces commercial producers into spray programs in order to control a pest they have eradicated from their orchard. Over the last few years, several areas in Washington State have been declared apple maggot quarantine areas.

In the February 2000 issue of ***AENews*** (No. 166) we discussed how pest boards help our agricultural producers deal with the problem of backyard fruit trees hosting pests that serve as a continual source of reinfestation. Pest boards advise homeowners to either cut down the tree or to spray with an appropriate material to control apple maggot. The spray material of choice was phosmet (Imidan) when it had a residential registration.

Several years ago, the U.S. Environmental Protection Agency (EPA) asked phosmet's registrant, Gowan, for toxicity data to support residential use and requested that Gowan begin to use child-proof packaging. No toxicity data was available and the registrant did not want to deal with the child-proof packaging requirement, so homeowner labels for this product were discontinued and commercial packages started carrying the statement "not for residential use." Washington State University (WSU) specialists switched to recommending diazinon to control apple maggot. Of the very few active ingredients effective on apple maggot to which homeowners have access, diazinon was the best choice. (For about a year, apples disappeared from homeowner diazinon labels, only to reappear later on, much to our relief.)

Now diazinon is being phased out. After EPA gave notice that diazinon's home and garden registration would expire of as of December 31, 2004, many

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IR-4 Projects, cont. from p. 17

Nematicide	Trade Name	Registration
Fosthiazate		Pending registration on amaranth, arugula, balsam apple and pear, banana, bittermelon, broccoli, Brussels sprouts, cabbage, cardoon, cauliflower, cavalo broccolo, celery, celuce, chervil, dandelion, dock, fennel, gherkin, gourd, kale, kohlrabi, lettuce, mizuna, greens, spinach, potato, pumpkin, squash, Swiss chard, tomato, and watermelon.
Methyl iodide		
Propargyl bromide		Being evaluated as part of IR-4's Methyl Bromide Alternative Program in strawberry and tomato.
Sodium Tetrathiocarbonate	Enzone	Registered on grapes, calamondin, citrus citron, citrus hybrids, grapefruit, kumquat, lemon, lime, tangerine, orange, and pummelo. Being evaluated as part of IR-4's Methyl Bromide Alternative Program in strawberry and tomato.
Telone	Inline	Being evaluated as part of IR-4's Methyl Bromide Alternative Program in strawberry and tomato.
ZA 3274	Terrapy	Potential use on tomato, carrot, cucumber, sugar beet, and potato. Early development stage. International use only.

Apple Conundrum, cont.

Dr. Catherine H. Daniels, Pesticide Coordinator, WSU

retailers simply discontinued stocking diazinon products. So even though the product is effective and can be legally recommended through 2004, if consumers can't find it to purchase, they certainly can't use it to control apple maggot. We were back to square one in the game of backyard apple maggot control.

This problem was recently solved. On July 9, 2001, the Washington State Department of Agriculture, at the request of WSU's Dr. Jay Brunner, issued a special local needs (SLN) registration, WA-010032, to address the situation. Imidan 70W can now be used up to four times per year in areas identified for treatment under the state-mandated apple maggot quarantine program. The SLN carries the restriction that application may be made only by certified applicators.

This is an unusual SLN in several ways:

1) it deals with residential use but does not allow homeowners to apply it;

2) its geographic boundaries are based on regulatory actions which can change over time;

3) and while the Section 3 (regular) label is not a restricted use pesticide, the SLN is. (EPA did not require residue, efficacy, or phytotoxicity data because the rate prescribed in the SLN is the same as that already approved on the Section 3 label, but they did require the SLN to be labeled as restricted use because it is residential.)

Applicators will need to obtain a copy of the SLN when they purchase the product from their distributor and each applicator is required to carry a copy of the SLN in his or her truck when making an application. This SLN, while complex, is a great boon to the state's apple producers because certified applicators can now treat backyard apple trees with phosmet if those trees are found by the local pest board to host apple maggot.

Catherine Daniels is the Pesticide Coordinator at Washington State University and Manager of the Pesticide Information Center on the Tri-Cities campus. She can be reached at (509) 372-7495 or cdaniels@tricity.wsu.edu.

IR-4 Projects, cont. from p. 17

Registrant	Mode of Action/Pesticide Activity
Syngenta, ISK	Partial methyl bromide alternative. Controls nematodes.
Tomen Agro	Similar to methyl bromide. Potential methyl bromide alternative.
Abermarle	Similar to methyl bromide. Potential methyl bromide alternative.
Entek Corporation	Carbon disulfide generator. Water-soluble soil fumigant. For management of plant parasitic nematodes, various soilborne pathogens, and other soil pests.
Dow Agrisciences	1,3,dichloropropene + chloropicrin. Partial methyl bromide alternative. Active against many soil inects, nematodes, and plant diseases.
Syngenta, Cognis Deutschland	Biopesticide. Novel mode of action. Fatty acid preparation in alkyl(poly) glycoside. Shown to significantly reduce ***Meloidogyne*** infestations.

Of Microbes and Men

Food Safety from the Farm to the Processor

Sally O'Neal Coates, Editor of Research Publications, WSU

Last month, I recapped Day One of the two-day Food Safety Farm to Table Conference. The conference, now in its ninth year, was held May 30 and 31, 2001, at the Best Western University Inn and Conference Center in Moscow, Idaho. It is a joint venture of the Cooperative Extension services of Washington State University (WSU) and the University of Idaho (UI).

The Food Safety Conference, as the name "Farm to Table" implies, covers a wealth of issues ranging from those faced by agricultural producers through those faced by food handlers to those in their own home kitchens. While Day One concentrated on information pertinent to consumers, Day Two focused on the farm and the food processing facility.

Dr. Dale Hancock of Washington State University (WSU) introduced the morning session. Following the lead of the traditional "Pathogens ***du Jour***" Day One opening segment of the conference, Day Two began with "Pathogens ***pour Demain***," or "Pathogens of Tomorrow." With his trademark self-deprecating humor, Dr. Hancock refused to tackle the French pronunciation of the morning's session in his Texas accent, though he did amuse us by mentioning Horse Doovers, a cocktail party snack popular in the South.

Water Worries

The day's first presenter was Dr. John Gay of WSU's Veterinary Clinical Sciences Department. He addressed the broad topic of rural water and its potential impacts on human health. In his presentation, he discussed recreational water, well water, and agricultural (irrigation) water. Of these three, the first two have demonstrated connections to human health risks. For agricultural water, the risk is less clear.

"Agricultural water" can come into contact with our food in several ways, including through irrigation, via cooling and frost prevention, as a fertilizer or pesticide carrier, and through post-harvest processing. Echoing a presentation from the previous afternoon, Dr. Gay recalled the increased incidence of produce-related foodborne illness (FBI) in recent decades (approximately double in twenty years). While a wide range of pathogens have been found on a wide variety of fresh fruits and vegetables, it's very difficult to trace the source of contamination on a product with such a short shelf life. (Of twenty-seven U.S. fresh produce outbreaks reported in the 1990s, the point of contamination was clearly identified in only two.) The source could be irrigation water, but is it? (Secondarily, when water is found to contain contaminants, can we definitively trace it to agriculture? We certainly see some high fecal coliform counts along the Yakima River when comparing the water sampled near its Cle Elum source to samples taken near the Tri-Cities outflow, but private septic systems have been implicated rather than agriculture.)

The bottom line is that we have no bottom line. The U.S. Food and Drug Administration lists agricultural water as a potential source of microbial pathogen contamination in produce, but acknowledges that there are no guidelines for determining hazard. Further research is needed, but without hazard guidelines, it is difficult to structure meaningful research.

Continuing the water theme, Dr. Barbara Rasco, who is both a food scientist and an attorney, addressed the jurisdictional problem attendant in water rights. Legal issues relating to water have mushroomed in recent years. Dr. Rasco outlined some of the many changes that are underway with respect to water rights and water contamination; these in turn are creating more opportunities for dispute. The Department of Ecology, for example, has released new guidelines for surface water quality. Requirements include:

- no degradation (clean water must not be polluted unless the act is shown to be necessary or in the public interest);
- stricter dissolved oxygen standards (to accommodate salmon and trout);
- tighter irrigation water standards (to prevent buildup of suspended solids, bicarbonate, and salts);
- maintenance of temperature (to accommodate salmon and trout);
- emphasis on enterococci (an intestinal bacteria) instead of fecal coliforms; and
- prohibition of fecal waste discharge.

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Microbes and Men, cont.

Sally O'Neal Coates, Editor of Research Publications, WSU

What about bacteria—is it a pollutant? Depending upon your point of reference, it may or may not be. While bacteria is certainly a pollutant under the Clean Water Act, it is not encompassed under current "pollutant exclusion" clauses in commercial liability and umbrella policies. Since individuals can and have been personally sued (and found negligent) for providing or using contaminated water in a food product (such as ice), Dr. Rasco suggested that parties in the line of fire review their liability insurance. While damage resulting from serving water contaminated with pathogenic microbes may currently be covered, there is some evidence that microbes may be increasingly excluded from coverage, the way hazardous waste and nuclear contamination are now.

With respect to water safety, there is a general tendency to broaden and deepen regulations already on the books. For example, pollution guidelines formerly affecting "navigable waters" are routinely being extended to tributary waters, including irrigation canals. The practical result of this interpretation is that irrigation districts may need to seek formal National Pollution Discharge Elimination System (NPDES) permits to use conventional herbicides in canals and, indeed, may not be able to use these products. Another disturbing trend for agriculture is that environmental risks (especially those to fish and other threatened or endangered species) tend to take precedence over the needs of people. She cited a case in Oregon's Klamath Basin where irrigation water was denied by the court to 90% of farmers in a 200,000-acre farming area. The ruling conceded that "the threat to the farmers is great, but the threat to the fish is greater."

Even following the rules may not be good enough. After a production plant in Virginia had an agreement with the state to temporarily exceed discharge levels during pipeline rerouting, EPA came in and imposed a fine on the production plant, saying it (EPA) was not bound to honor the state's agreement. The EPA fine was upheld in court.

Mad Cows and Englishmen

With our heads whirling in the vortex of water issues, we left irrigation behind and turned our attention to another "pathogen ***pour demain***," the dreaded mad cow disease. Dr. Clive Gay addressed "Bovine Spongiform Encephalopathy: Could It Happen Here?" Dr. Gay, with WSU's Veterinary Clinical Sciences, began by offering a short answer to the question. Could it happen here? Yes, of course. Nearly anything is possible. What is the likelihood it will happen here? Very low.

Dr. Gay outlined the history of BSE in Britain. Its first appearance in the scientific literature was a British journal article from 1987 that called BSE a "novel" disease, one with very little likelihood of actually occurring. Less than a decade later, it was epidemic. The United Kingdom (UK) stopped serving beef in school lunches, a significant proportion of the population stopped eating beef, and over 100 British individuals were shown to be infected with a variant of Creutzfeldt-Jakob Disease in which BSE has been implicated.

BSE appeared simultaneously throughout Britain, with a large number of herds (especially larger herds) affected. It was found to have no association with similar disorders in sheep. In the end, meat and bone meal consumption was incriminated as the source of infection and sanctions were immediately put into place against using meat and bone meal in cattle feed. Perplexingly, some 28,000 BSE-affected cattle were born after the ban. As it turned out, the recurrence was traced to illegal use of meat and bone meal and inadvertent cross-contamination of cattle feed with feed for other species. (Early in the course of the outbreak swine and poultry feeds were still allowed to contain ruminant-derived meat and bone meal.) The cross-contamination problem was curtained when Britain placed a total ban on feeds containing ruminant meat and bone meal. Further compounding the problem was the fact that cattle feed containing meat and bone meal had not been seized at the onset of the ban; cattle producers tended to use the stocks they had on hand. By initiat-

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Microbes and Men, cont.

Sally O'Neal Coates, Editor of Research Publications, WSU

ing an attractive buyback program in 1996, the government was able to curtail this problem.

What lessons can we learn, should BSE happen here? The UK has an excellent tracking system for its cattle, which helped. Bans and sanctions are only as good as the enforcement of them. The British banned meat and bone meal, but that didn't stop people from using it. The French were extremely aggressive, immediately destroying the entire herd when one infected cow was found; this resulted in gross underreporting.

What have we already done in the United States? Shortly after it became apparent that contaminated meat and bone meal was the vehicle of spread for outbreak in Britain, the U.S. government imposed a ban on the feeding of ruminant meat and bone meal to ruminants. The U.S. Department of Agriculture (USDA) contracted with Harvard several years ago to conduct a risk analysis; this analysis has not yet been released. We have banned imports of beef and beef products from nations with reported BSE (beginning with the UK, but expanding as other nations reported the disease). We have monitored cattle imported in the past from BSE-reporting countries. The final prohibition was instated in 2000, banning import of all rendered animal products. We have conducted some brain testing in suspect U.S. cattle; of 11,954 tested during 1986 through 2000, all have been negative. It has been suggested that this testing program could be better targeted or more extensive.

Some questions remain. Who monitors meat and bone meal? What is occurring in the world trade of meat and bone meal? Can BSE infect sheep? Is the BSE that has been found in ostriches an infective strain? What will the Harvard report tell us?

The disease is difficult to study for many reasons, including its long incubation period. While calves can be infected, it generally does not show up until the cow is four to five years old. Symptoms include changes in behavior, but they generally take the form of apprehension rather than frenzy (e.g., dairy cows refusing to enter the milking parlor); in this regard, "mad" cow disease is an unfortunate misnomer.

Antimicrobial Resistance

After the break, Dr. Hancock introduced molecular epidemiologist Dr. Doug Call. Dr. Call came to the WSU Department of Veterinary Microbiology and Pathology through the Washington State Safe Food Initiative.

Antibiotic resistance is important in food safety because antibiotics are widely used in veterinary medicine and food production (meat, poultry, fish, fruit and vegetables), because antibiotics tend to promote resistance, and because there is a risk of dissemination of this antibiotic resistance to humans. As antibiotics play a key role in treating many human illnesses, it is not a good idea for humans to inadvertently develop resistance to the effectiveness of these healthcare tools.

Dr. Call explained the various mechanisms by which antibiotics work (inhibiting DNA synthesis, RNA synthesis, protein synthesis; damaging cell membranes; substituting metabolic analogs) and mechanisms by which resistance occurs (entry inhibition, active efflux, enzymatic modification, mutation of target, active target protection, active target modification, alternative targets).

Ways in which we can limit antibiotic resistance depend upon the nature of the resistance. In general, we can be prudent in the use of antibiotics. For example, some 40% of antibiotics prescribed for human healthcare are prescribed for viral infections, against which they are entirely ineffective. We can limit the use of antibiotics in livestock growth promotion. We can employ good hygiene with respect to antibiotic deployment, just as we do with other potential contaminants. We can also seek alternative ways to accomplish the objectives for which we currently employ antibiotics.

Dr. Dale Hancock took the podium to continue the discussion on antimicrobial resistance of foodborne

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pathogens. Dr. Hancock's contention is that we will continue to lose the war against antimicrobial resistance until we learn to expand our thinking beyond the current paradigms. In the case of ***Salmonella***, conventional wisdom suggests that

- livestock are the source of most ***Salmonella*** infections in humans in the United States;
- resistant ***Salmonella*** most likely emerge genetically on the farm;
- a small number of resistant animals are imported; and
- there is no human reservoir for resistant ***Salmonella***.

It is, therefore, also conventional wisdom that if simultaneous increases in resistance occur on a variety of geographically dispersed farms, this is coincidental and the cases are independent of one another, each originating through independent evolutionary sequences. For ***Salmonella***, however, Dr. Hancock makes the case that a widespread, multi-drug resistant strain (DT-104) originated from a single clone of bacteria and then spread rapidly around the world, possibly via human carriers.

While Dr. Hancock does not discount prudent use of antibiotics in livestock rearing, he advocates paying increased attention to controlling dissemination of infectious diseases both within and between livestock operations. Biosecurity and strict sanitation practices, particularly in high-risk areas such as contract calf raisers, should be practiced to reduce the spread of infectious diseases and antimicrobial-resistant bacteria. In the long-run, these improved practices might also reduce the overall need for some antibiotics thereby reducing production costs and potentially helping reduce prevalence of resistant strains of bacteria.

The content of this presentation was serious, thought provoking, and highly intellectual, but it also won my award for Most Entertaining of 2001. Dr. Hancock's enthusiasm is always contagious, and his audience-participation quizzes and whimsical slide animations were a welcome diversion.

HACCP: Hazards, Headaches

Hazard Analysis Critical Control Point (HACCP) is a proactive hazard prevention concept designed by the U.S. Food and Drug Administration (FDA). It is a seven-point program for designing a food processing plan that minimizes the risk of transmitting foodborne pathogens to the public. HACCP was made mandatory about five years ago with respect to seafood products, followed by meat and poultry two years later. The latest phase began January 2001, when HACCP standards were mandated for the juice industry. Along the way, many food processors not yet covered by federal HACCP regulation have voluntarily begun adopting HACCP programs or using HACCP ideas to formulate their own in-plant safety programs. HACCP was addressed by a panel of experts, ably moderated by WSU's own Dr. Richard Dougherty of the Food Science and Human Nutrition Department.

Claudia Coles, Program Manager for Food Safety Compliance with the Washington State Department of Agriculture (WSDA), represented regulators. She explained WSDA's oversight and inspection role in the state's commercial food production. WSDA has been using HACCP techniques in their seafood inspections as well as applying them proactively to other industries. For example, a pilot program for dairy HACCP is currently being developed.

Dr. Jeff Kronenberg, a Food Processing Specialist with UI, also has an extensive background in industry. In practice, says Dr. Kronenberg, there are three types of HACCP: "regulatory HACCP," "customer HACCP" (when a HACCP program is mandated by purchasers of a product), and "scientific HACCP." He pointed out the tremendous variety of food safety concerns between various types of food products.

All panel members emphasized the importance of HACCP training. Training is complex and putting it into practice can be time-consuming, due both to employee turnover and to the constantly evolving science of food safety. Training quality is inconsistent and follow-up is not always rigorous. Poor training begets poor training, which in turn begets faulty

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Microbes and Men, cont.

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HACCP plans. The HACCP concept is hands-on; it should flow from a well-trained coordinator and be built "from the ground up" by a team of workers at each facility. It should not, indeed cannot, be a boilerplate, "one-size-fits-all" program passed from one facility to another, nor from an independent consultant to a facility, nor from software without flexibility to adapt to particulars in each facility.

The panel and audience members, many of whom were county health regulators, related case studies that illustrated misinterpretation of the HACCP concept, faulty formulation of HACCP plans, or incorrect implementation of an appropriate HACCP plan.

While smaller companies may be daunted by the paperwork involved in building and following a HACCP plan, it should be clear that such a plan benefits everyone. The bottom line for HACCP success (though this is not in any written regulation and cannot be enforced nor even objectively assessed) is that there must be commitment on the part of employees and management to fully support the program. Successful HACCP can be sabotaged in scores of small and sometimes subtle ways.

In conclusion, the panel asked, "What have we learned in the past five years?" The short answer is that (a) HACCP is well conceived but can be complicated; and (b) successful implementation takes time.

As always, this year's Food Safety Farm to Table Conference was a great success. Watch for dates and topics for next year's conference in the pages of ***AENews*** next spring or point your Internet browser to **http://foodsafety.wsu.edu**.

Sally O'Neal Coates is the editor of AENews ***and an occasional contributor. She can be reached at scoates@tricity.wsu.edu or (509) 372-7378.***

New Food Safety Publication for Apples

Washington State University (WSU) Cooperative Extension has recently released ***Reducing Food Safety Risks in Apples: A Self-Assessment Workbook***. The workbook, based on the U.S. Food and Drug Administration (FDA) Good Management Practices and Hazard Analysis Critical Control Point (HACCP) guidelines, serves as a tool to help growers and processors identify potential sources of microbial or pesticide contamination in their operations and offers guidelines to limit contamination risks and to prevent foodborne illness from fresh fruit or cider. It follows the self-assessment checklist format used in the Home-A-Syst and Farm-A-Syst water quality assessments.

The workbook was produced as part of a joint project between WSU, the University of Wisconsin, and the University of Vermont. Wisconsin and Vermont produce more fresh cider in proportion to their fresh-packed fruit output than Washington. These direct marketers, who may not have procedures in place to reduce contamination risks, are a primary audience for the workbook. However, the workbook can also be used by any grower and may be a good educational tool for packing houses to use with their growers to reduce potential contamination risks in the orchard.

A copy of the workbook can be viewed and downloaded from the WSU Tree Fruit Research and Extension Center website (**http://www.tfrec.wsu.edu**). Click on "Reducing Food Safety Risks in Apples." The project was funded by a grant from the U.S. Department of Agriculture's Cooperative Research, Education, and Extension Service (USDA-CREES). For more information, contact David Granatstein at (509) 663-8181 x222, or **granats@wsu.edu**.

Pesticide Container Recycling Schedule

Washington Pest Consultants Association

Washington Pest Consultants Association (WaPCA) contracts with Northwest Ag Plastics to collect and recycle plastic pesticide containers. Containers should be clean and dry, with lids removed. For more information on the program, contact Clarke Brown at (509) 965-6809, Dave Brown at (509) 961-8524, or NW Ag Plastics at (509) 457-3850. The table below shows dates for August and early September only; a complete schedule through October is on-line at **http://pep.wsu.edu/waste/wapca.html**. For information on a specific collection date or site, call the contact number listed in this table. THERE IS NO FEE FOR THIS SERVICE.

DATE	TIME	LOCATION	SPONSOR	CONTACT	PHONE (509)
Aug. 7	8a-10a	Ephrata	The Crop Duster	Martin Shaw	754-3461
	1p-3p	White Trail			
Aug. 8	8a-10a	Quincy, Road 4 NW	Wilbur Ellis	Randy Wentworth	787-1565
	1p-3p	K Road NW	Weber Farms	Arnie Greenwald	787-4578
Aug. 9	8a-10a	Royal City	Simplot	Laura Goroski	346-2223
	1p-3p		Cenex	Ted Freeman	346-2212
Aug. 10	8a-10a	Royal Slope	Zirkle Fruit	Ismael	952-8139
Aug. 20	8a-10a	Prescott	Broetje's Orchard	Joe Shelton	749-2217
			Flat Top Ranch	Dave Hovde	547-9682
	1p-3p		Agri Northwest	Shawn Elder	547-8870
Aug. 21	8a-10a	Walla Walla	McGregor Company	Gary Burt	529-6787
	1p-3p	Waitsburg		Terry Jacoy	337-6621
	4p-?	Pomeroy		Steve Ledgerwood	843-1468
Aug. 22	8a-10a	Mockonema	McGregor Company	Dale Deerkop	397-4691
	1p-3p	Colfax	Grange Supply	Darrel Tyler	387-4353
Aug. 23	8a-10a	Pullman	McGregor Company	Larry Schlenker	332-2551
	1p-3p	Dusty	Dusty Farm Coop	Chris Crider	397-3111
Aug. 24	8a-10a	Mattawa	B&R Crop Care	Chris Eskildsen	234-7791
	12p-2p		Windflow Fertilizer	Monte Spence	932-4988
	3p-5p		Wilbur Ellis	Al Hilliker	932-4988
Sept. 4	8a-10a	Sunnyside	Bleyhl Farm Service	Vern Bos	839-4200
	1p-3p	Zillah		Dan Simmons	829-6922
Sept. 5	8a-10a	Toppenish	Kenny Sealock Farms	Ken Sealock	865-6119
	1p-3p	Buena	Heli-Flight	Bill Fork	453-0345
Sept. 11	8a-10a	Wilbur Airport	Greg's Crop Care	Greg Leyva	647-2441
	1p-3p	Davenport	Northwest Aviation Inc.	Lee Swain	725-0011
Sept. 12	8a-10a	Odessa	Smith Air Inc.		982-2231
Sept. 13	8a-11a	Moses Lake	Tom Dent Aviation	Tom Dent	765-6926
	2p-4p		Moses Lake Air Svc.	Perry Davis	765-7689
Sept. 14	8a-10a	Warden	Wilbur Ellis	Brian Preston	349-2333
	1p-3p		Kilmer Crop Dusting	Terry Kilmer	349-2491

"Our industry does not want pesticide containers to become a waste issue. If we take the time to clean and recycle these products, we can save money, show that the industry is responsible in its use of pesticides, and reduce inputs to the waste stream."

Down the Garden Path with HRH QBL

Jane M. Thomas, Pesticide Notification Network Coordinator, WSU

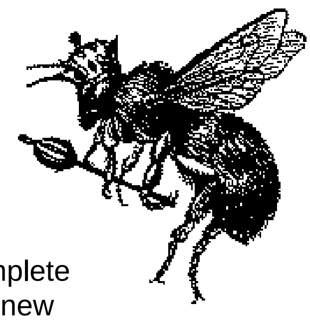
In the August 2000 ***Agrichemical and Environmental News*** (Issue No. 172), the Queen Bee of Labels (QBL) introduced the concept of the Non-Anomaly awards for spectacularly lousy pesticide labels. Her Royal Highness originally intended to call these Label Anomalies, but was set straight by Webster's definition of "anomaly," to wit: "departure from the regular arrangement, general rule, or regular practice." As we are all aware from the QBL's regular Royal Rants in these pages, there are no rules and nothing regular where pesticide labels are concerned. Thus, the Non-Anoms were born.

Because of the sheer volume of breathtakingly queer pesticide labels, the Non-Anoms were broken into various categories. In November 2000 (***AENews*** Issue No. 175, "Call It Confusing, Call It Contradictory…") HRH introduced the ***Down the Garden Path*** Non-Anom award. This category was needed to encompass particularly pathetic and aggrievedly awful pesticide labels bent on leading pesticide users astray. Well hang onto your hats, two new labels have taken on a life of their own and have simply **insisted** on being entered in this category. Roll over Riverdale, you have some competition.

The first entrant who pushed and shoved its way ***Down the Garden Path*** is the Talstar 0.069% Plus Fertilizer label from Lesco. Just under the product name on the label is the following paragraph:

> Only for sale to, and storage by commercial applicators for use to control ants (including imported fire ants), mole crickets and other listed pests on grass (including golf courses).

However, under Directions For Use, farther down on the label, it says "Not for use on golf courses, sod farms, nurseries, commercial greenhouses or grass grown for seed." To be completely honest (as one in such a Lofty Position must) it appears that this label, submitted to the Oregon Department of Agriculture (ODA) and forwarded to WSU's Pesticide Information Center, is a draft version, yet it is the label Lesco submitted with its 2001 registration materials. According to Dan Blevins, ODA's trusy pesticide registration guy, this label was also noteworthy to the department because the fertilizer percentages were missing. ODA contacted Lesco and required that the company supply a more complete label. According to Dan, the new label not only includes the fertilizer information, it no longer includes the Great Golf Course Gaffe. WSU's Pesticide Information Center is waiting with baited breath to receive a copy of the corrected label.



Moving along, the second entrant is a decidedly visual blunder. (The QBL lauded litigious layouts in "The QBL Gets Graphic," Issue No. 176, December 2000.) Bonide's Copper Spray or Dust ("Bonide: Trusted Since 1926") sports a colorful photo of luscious, eye-catching, mouth-watering, flavorful (you can just tell) blueberries just above the words "Controls disease on potatoes, tomatoes, fruits, flowering shrubs, and shade trees." Now I'm not sure about any of you but were the QBL in the market for a fungicide to use on her regal and prized blueberries she, a visual sort as most good leaders are, would definitely pluck this Bonide product off the shelf. The only problem is that Copper Spray or Dust is not labeled for use on blueberries. It is not labeled for use on small fruits, let alone little round blue fruits. The QBL believes that Bonide has been caught in a National Enquirer-like photo fib. It should go without saying that the QBL frowns on lies in all forms: words, photos, and deeds.

Were the QBL not such a lofty sort, she might resort to "Liar, liar, pants on fire" to both Bonide and Lesco for their ***Down the Garden Path*** misdeeds. Trusted Since 1926 - **really!**

Jane M. Thomas crowned herself the QBL in the May issue of AENews ***(No. 169) when she wrote, "If I Were the Queen of Labels." She can be reached at (509) 372-7493 or jmthomas@tricity.wsu.edu***

Insect of the Month
Dragonfly

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Dr. Douglas B. Walsh, Entomologist, WSU

This column often features a pest insect that is a nuisance to the homeowner or has economic impact on the agricultural producer. This month, we are featuring the dragonfly, a beneficial arthropod that acts as a predator to nuisance insects. Dragonflies can eat huge numbers of mosquitoes over the course of their lifetime.

Background

Dragonflies are insects in the order Odonata, which comes from the Latin for "toothed jaw," in reference to the dragonfly's powerful biting mouthparts. Dragonflies are truly an ancient group of insects, having persisted on earth for almost half a billion years. Historically, dragonflies reached a zenith in the tropics of the Carboniferous period (300 million years BCE) when species with wingspans greater than two feet soared through ancient forests. Today's dragonflies are sub-compacts when compared to their ancient forebears; the largest species in the Pacific Northwest has a wingspan of about four inches.

Anatomy

Well-designed wings are key to the dragonfly's success as an aerial predator. The four wings attach directly and independently to the thorax with powerful muscles that enable the dragonfly to quickly attain and decelerate from speeds of over thirty miles per hour. The thorax is angled so that the wings are pushed back and the legs are pushed forward, resulting in an efficient center of gravity and a design that puts the hindwing just outside the zone of turbulence created by the forewing. Dragonfly wings beat at twenty to ninety cycles per second. Each wing is capable of independent movement, enabling dragonflies to hover as well as fly backward, forward, and sideways.

To achieve these feats of aerobatics, a dragonfly's head serves as biological gyroscope. The head is suspended on the pointed tip of the thorax and rests in an upright position under the influence of gravity, thus telling the dragonfly which way is up.
A dragonfly's large compound eyes can take up two-thirds of its head. Each eye consists of about 30,000 tiny facets that enable easy detection of predators and prey.

The legs of the dragonfly form a net-like basket that rests directly under the insect's mouth, enabling the dragonfly to hold its food and eat while flying. As the root of their name implies, adult dragonflies have biting mouthparts adapted to crunching the exoskeletons of the insects they catch.

Larval dragonflies have a few anatomical advantages of their own. They use a jet-propulsion system to escape predators. The larvae breathe by taking water through the anus into a gill-lined cavity. When frightened, they are able to contract this cavity, which shoots water out behind and propels them forward.

Life Cycle

Dragonflies can be univoltine (one generation per year) or multivoltine, depending on species, geography, and climate. Different species exhibit different egg-laying techniques; some females skim water surfaces and release their eggs like bombers, others insert eggs into plant material at the water's edge. Eggs laid during the summer can hatch within a few weeks, while eggs laid in fall typically overwinter and will not hatch until the subsequent spring.

Dragonfly larvae are aquatic; as mentioned above, they breathe by means of gills. Living in ponds, lakes, and streams, they feed on aquatic insects, tadpoles, minnows, and crustaceans. Larval maturation is highly variable, dependant upon climate and nutrition. In cold water, where food is hard to obtain, larval development taking up to five years has been documented.

When the adult is ready to emerge, the larva climbs onto a plant or stone near the water's edge. The larval cuticle splits at the thorax and the new adult dragonfly slowly extracts itself. Hemolymph (insect blood) pumps into the wing veins to expand the wings. After hatching, adults often leave the pond for a week or two in search of insect populations further

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Dragonfly, cont.

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afield. When dragonflies mature sexually they return to wetland areas to mate and breed.

Dragonfly sex deserves a write-up in the Kama Sutra. Males have "accessory genitalia" on the underside of the abdomen base. In mating, the male grasps the female at the back of her head with appendages on the end of his abdomen. In response the female curls her hind end up to the male's accessory genitalia to collect the sperm, resulting in a wheel-like configuration.

Male dragonflies are more commonly seen than females, since they defend a territory and actively engage in attracting females. Adult dragonflies typically live less than ten weeks.

To obtain further information on dragonflies of the Pacific Northwest, I would encourage you to visit **http://www.ups.edu/biology/museum/UPSdragonflies.html**. This website, maintained by the University of Puget Sound, contains good pictures and descriptions of the dragonflies in Washington State and details of the Washington Dragonfly Survey that began in the summer of 1997.

Dr. Doug Walsh is an Entomologist with WSU and a frequent contributor to Agrichemical and Environmental News***. He can be reached at (509) 786-2226 or dwalsh@tricity.wsu.edu when he is not out in the field looking at bugs.***