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Archived at: <http://131.104.232.9/agnet-archives.htm>

FDA-BIOTECH FOOD

June 17/03

AP

By EMILY GERSEMA

Associated Press Writer

WASHINGTON -- FDA Deputy Commissioner Lester Crawford was cited as telling the U.S. Congress Tuesday that genetically engineered foods from crops that have already been reviewed and approved by two government agencies shouldn't have to jump through a third regulatory hoop at the Food and Drug Administration, and that the agency is inclined to reject a proposal made by the former Clinton administration that would require biotechnology companies to notify the FDA before putting products on the market, adding, "The current system is working. Since there is no public health reason to impose mandatory requirements, FDA is not making this rule a priority."

Crawford was further cited as saying he knows of no instance where a company has not voluntarily shared field tests and other information on its biotech products with the FDA.

Greg Jaffe, biotechnology director for the Center for Science in the Public Interest, was cited as saying that without a regulation requiring it, companies could withhold data, adding, "Under the current system, they could market something without us even knowing it. That is not the best way to ensure the safety or instill consumer confidence in these crops."

Lisa Dry, a spokeswoman for the Biotechnology Industry Organization, was cited as saying companies share their data with the FDA because after a review, the agency gives them a letter approving the products and that without the letter, a company would never be able to get its biotech crops to market, explaining that food processors require the letter in order to do business, and adding, "They treat it as though it were mandatory because if they don't, they won't get a letter of review so that they can sell their product."

The EPA also has a role in checking food safety if a company is seeking approval to grow a crop genetically designed to contain a pesticide to fight insects. The EPA approves those crops only if they are safe for people to eat and if they won't harm the environment.

Food and Drug Administration: <http://www.fda.gov/>

POPCORN COULD HELP CONTROL INSECT POPULATIONS

June 17, 2003

Iowa State Daily

Debra Reschke

<http://www.iowastatedaily.com/vnews/display.v/ART/2003/06/17/3eee83574fbd0>

Popcorn may prove to be a blessing in insect resistance management, or Bt (*Bacillus Thuriagensis*) corn crops, experts said Tuesday.

Colothdian Tate, graduate student in entomology, spoke to a crowd of about 30 Tuesday night in Lagomarcino E164 about the benefits of popcorn.

Popcorn was the topic of Tate's dissertation defense entitled "Popcorn: A potential refuge for resistance management of European corn borer and corn rootworms."

Bt corn is a crop genetically engineered to be resistant to certain insects, Tate said.

The Environmental Protection Agency (EPA) requires all farms producing Bt corn to plant an area of non-Bt corn which is called a refuge, according to the EPA Web site, www.epa.gov. These plots are important in providing a place for European corn borers and corn rootworms to mate.

Tate said conclusions made by his experiments could allow for reductions in the areas of refuge required, which will increase the value of planting popcorn.

Corn borers and corn rootworms together annually cause over \$2 billion worth of costs in crop damages and expenses in control measures, Tate said.

However, they must be allowed a place to reproduce so the insects susceptible to the Bt toxins can mate with the insects resistant to the toxins, according to a University of Nebraska (Lincoln) Web site,

<http://agbiosafety.unl.edu/education/refugebuilder/refugebuilder.htm>. The

pests must mate together to produce offspring that are susceptible to the Bt toxin.

Transgenic corn production, or Bt corn, for controlling corn rootworms was approved by the EPA in 2003, Tate said.

He said farmers can plant 80 percent of their acres with Bt corn and must plant at least 20 percent of their land with refuge by EPA standards.

In an experiment Tate conducted for his dissertation, he planted plots of popcorn as a refuge.

Significant differences in European corn borer larvae were observed in the popcorn plantings. He said three times more larvae was produced in the popcorn per meter.

The corn rootworms in the popcorn were found to develop late, Tate said.

This is considered to be beneficial since the transgenic beetles, which are resistant to Bt toxins, emerge later in the season. The nonresistant beetles are able to mate with the resistant beetles, which causes larvae from the union to be susceptible to Bt toxin.

"If we can hone down the refuge area, even if the refuge crops are a total loss, we will be taking less land away, which puts the farmer on top," said Robin Pruisner, entomologist for the Iowa Department of Agriculture. "More

land towards transgenic corn and less refuge is a win-win situation for [the state] and the farmers."

Pruisner said Iowa Secretary of Agriculture, Patty Judge, is concerned about biotechnology partly in response to environmentalists' worries of the effects on the environment produced by crops such as Bt corn.

She said more people are getting worked up about the issue and the state department is interested in trying to find a more financially profitable way to solve the present problems.

The problem with the popcorn plantings is the farmer might not have a contract for producing popcorn, said Jon Tollefson, professor of entomology.

He said it might be more economically successful to plant an extra two or three refuges rather than spend money on popcorn the farmer cannot sell.

Richard Hellmich, collaborator in entomology, said planting popcorn may prove to be more useful when the refuge requirements are reduced in size.

But for now, the beetles have to mate in the refuges, said Tollefson.

"It's similar to a college bar," Pruisner said, "The females are calling the guys and the guys are cruising for chicks." Going along with the analogy, Tollefson said the bar is the refuge site where the nonresistant insects are mating with the resistant insects.

"We are bringing the bar to the beetles to encourage the mix," Tollefson said. "There's a bar in every [Bt] field."

ILOILO CHURCH LEADERS CHECK ENTRY OF BT CORN

June 16, 2003

Phillipine Daily News

http://hoovnews.hoovers.com/fp.asp?layout=displaynews&doc_id=NR20030616670.2_af5a00179b85d8bb

ILOILO CITY-The social action center of the Archdiocese of Jaro has, according to this story, asked farmers to report to their parish priests any attempt to grow genetically modified corn or Bt corn.

Fr. Meliton Oso of the Archdiocesan social action center was cited as saying in a news conference on June 10 that he asked farmers affiliated with the sustainable agriculture program, to inform their priests if Bt corn seeds were being distributed in corn growing areas. Oso said some farmers reported that Monsanto corn seeds were seen in Sara town, 102 kilometers north of this city, but they could not determine if they were hybrid or Bt corn.

Sara and San Dionisio towns are the biggest corn growing towns in Iloilo that has the total corn area of 4,000 hectares.

SUDAN: GOVERNMENT REVIEWING POLICY ON GM FOOD IMPORTS

June 17, 2003

IRINnews.org

http://www.irinnews.org/report.asp?ReportID=34787&SelectRegion=East_Africa&SelectCountry=SUDAN

Nairobi - The Sudanese government has, according to this story, guaranteed the World Food Programme (WFP) that all food deliveries will be permitted to enter the country for the next six months, while it conducts a review of its policy on genetically modified (GM) foods.

"The government informed us verbally that it will review its policy on GM foods over the next three months," a spokesman for WFP, Robin Lodge, told IRIN on Tuesday.

A number of food shipments held up in Port Sudan for over a week due to concerns about GM food were released by Sudanese authorities on Saturday.

OFFICIAL GM REPORTS 'FLAWED'

June 17, 2003

Australian Associated Press

A new report compiled for the Australian Network of Concerned Farmers and the Twynam Agricultural Group was cited as finding that official reports backing the release of genetically modified crops contained major flaws and were biased towards GM technology..

The story says that in the past 12 months, the Australian Bureau of Agricultural and Resource Economics, the Productivity Commission and University of Melbourne have all released reports highlighting the economic benefits of GM crops.

But the new report said there were doubts over the claims because of assumptions used by the three organisations.

It said in one case, the Productivity Commission claimed growing acceptance of GM foods by consumers while demand for genetically altered products had actually fallen.

The financial benefits of genetically altered crops sold by other countries could be attributed to other factors, the report found.

There was also no recognition of the costs to farmers of segregating GM from non-GM crops.

Spokeswoman for the network, Julie Newman, was cited as saying the new report showed much more work had to be done on the true financial impact of genetically altered crops, adding, "This critique, by professional economists, confirms our concerns that there are significant issues that need a more considered assessment. The critique highlights that the reports have relied on unsubstantiated data of benefits, ignored a wide range of likely costs, and presumed that current consumer rejection will be replaced with consumer acceptance. It also points out that non-GM canola farmers will

be expected to subsidise the introduction of a GM canola industry, yet this has not been accepted by non-GM growers."

The story notes that most states have announced a short-term ban on GM crops pending further studies into their safety and environmental impact.

A decision on a GM canola from Bayer CropScience, which was expected to be approved this week, will be delayed for at least a month.

HOW LOW CAN YOU GO? ASSESSING REDUCED APPLICATION RATES FOR CODLING MOTH CONTROL

May 2003

Agrichemical and Environmental News, Issue No. 205

Dr. Allan S. Felsot, Environmental Toxicologist, WSU

<http://www.aenews.wsu.edu/May03AENews/May03AENews.htm#SprayerTech>

Once upon a time, a grower could make an honest living selling beautiful fruit across our country. Washington State growers were handsomely rewarded for providing an abundance of healthful commodities. But global realities and reduced markets have taken their toll; today, growers are just scraping by to make ends meet. As production techniques become ever more efficient, the result can be too much of a good thing. Market gluts naturally reduce prices, yet grower expenses keep going up. Ironically, growers are penalized the better they get. Is there a way out of this dilemma?

The Washington tree fruit industry thinks so and the answer is reducing production costs through innovative technology. This strategy makes sense because production costs are the only part of the equation growers can control; they cannot affect the price of commodities. As the price of commodities continues to decline, the tree fruit industry has set a goal of reducing production costs by 30%. Labor and agricultural chemicals are major production inputs; cost savings in these areas will be critical in reaching this goal.

Although full implementation of ecologically based integrated pest management (IPM) systems has the potential to dramatically reduce use of chemical controls, traditional pesticides will remain a main tool in any IPM system. Coincident with the pressure to reduce inputs, the Food Quality Protection Act (FQPA) has triggered reassessment of all pesticides. The organophosphate insecticides azinphos-methyl (Guthion) and phosmet (Imidan) remain the most reliable and least costly products for codling moth control (Figure 1). However, EPA during 2002 issued a time-limited tolerance for residues of these products on fruit (see ³Adios, Azinphos-Methyl, Farewell Phosmet,² AENews Issue No. 191, March 2002,

<http://aenews.wsu.edu/Mar02AENews/Mar02AENews.htm#AZMPhosmet>). Within four

years, these pesticides could lose their registrations unless the manufacturers generate new information to refute EPA's concerns about worker safety. Adding to the mix, the Endangered Species Act is bringing ecological concerns about these products into the mainstream.

If our overall goal is sustainable production of safe and plentiful commodities, we must pay attention to input costs and all aspects of pest control, including insecticide resistance management. Maintaining the use of current chemical controls, but integrating them with the newer, reduced-risk products and codling moth mating disruption would be a step in the right direction. Thus, efforts need to focus on reducing use without sacrificing control efficacy.

Sprayer technology, a comparatively neglected area of research, could help reduce pesticide costs while meeting increasing demands for environmental stewardship. The fine-tuning of sprayer technologies has the potential to reduce volumes of water, amount of active ingredient, and off-target drift.

Furthermore, alternative sprayers (i.e., alternative to conventional airblast machines) may be better suited to precise targeting of the newer reduced-risk, low-application-rate chemicals and microbial pesticides. We see a need for increased research focusing on application technology. In particular, research should compare spray deposition from various sprayer types, characterize efficacy of reduced application rates using alternative sprayer technologies, and quantify resulting pesticide residues and their decline rates (i.e., residual efficacy over time). With funding from the Washington Tree Fruit Research Commission, we have been testing reduced application rates with a newer reduced-volume, air-assisted sprayer and comparing results to a conventional airblast sprayer (Figure 2).

Specifically, we are determining whether insecticides used for codling moth control will still be effective if applied at half the rates recommended on the product labels.

The Proptec sprayer is one example of a comparatively new sprayer technology that looks promising for saving growers time (which translates to labor expense) and money (through reduced rate of chemicals applied). The Proptec system employs a series of large fans mounted on a vertical boom (figure 2).

Each fan surrounds the spray nozzle. The fans can be articulated at different angles so that the spray is directed precisely to the foliage.

Another advantage of the Proptec is that the spray can be delivered using far less water (about 30-50 gallons per acre) than the conventional airblast sprayers (about 100-200 gallons per acre). Use of less water per acre sprayed will save labor and fuel by requiring less time out of the orchard for tank mixing and filling. Thus far, the Proptec sprayer has been most often deployed in vineyard production where the boom itself can be articulated to wrap around the trellised grapes.

To test the hypothesis that reduced application rates can effectively

control the codling moth and to compare the performance of Proptec and airblast sprayers, we defined experimental blocks in a commercial orchard west of Quincy, Washington (Figure 3). We sprayed plots with Guthion or the new reduced risk insecticide Intrepid (methoxyfenozide) at either the label recommendation rate (1X) or half of the label rate (0.5X). Afterward and throughout the growing seasons we collected foliage and apples from the middle and top of the canopy (Figure 4). To determine the effectiveness of the insecticides and their residual persistence, we bioassayed codling moth larvae by placing them in direct contact with the leaves and apples (Figures 5, 6). For the trees treated with Guthion, we also analyzed residues on leaf and apple surfaces. Finally, we determined the toxicity of the insecticides against codling moth larvae feeding on leaf surfaces (Figure 7).

We're still processing data at this writing, so I can only present our preliminary analysis of the results from trees treated with reduced rates of Guthion and compare the performance of the sprayers at this writing. The airblast and Proptec sprayers gave similar distributions of Guthion residues, whether leaves were collected from the middle or the top of the canopy (Figures 8, 9). On most collection days, we did observe somewhat higher residues at the top of the canopy from the Proptec sprayer than from the airblast sprayer, but differences were not statistically significant.

Guthion residues from the first application dissipated from leaf surfaces at about equal rates regardless of the sprayer that was used and the application rate. On the other hand, residues after the second application of Guthion seemed to decline more rapidly than after the first application (Figures 8, 9). Possible reasons include much higher temperatures in late July, which would increase volatilization, and greater frequency of overhead irrigation, which would increase wash-off from the leaf surfaces.

Guthion residues remained higher than the LC95 for at least 30 days after application (Figures 8, 9). As a rule of thumb, we expect residues above the LC95 to kill all of the larvae that come in contact with the pesticide. When we bioassayed the leaves from different collection dates, we observed that 90-100% of larvae died on samples collected 30 days after application (Figure 10, 11). However, many larvae survived on leaf samples collected about 30 days after the second application. Thus, the results from the codling moth bioassay and the residue analysis were consistent with one another.

Most importantly, the reduced application rate of Guthion (0.5X) caused larval mortality percentages very similar to the full rate (1X) (Figures 10, 11). Although application rate did not affect how long bioactivity lasted, percentage larval mortality decreased more quickly after the second application than after the first, again coinciding with the dissipation rate of the residues.

Efficacy of Guthion against codling moth larvae placed on apples did not

last as long as residues on foliage (Figure 12). The test that we used was very conservative: five larvae were placed on the surface of the apple and then the apple was examined for entry holes. Efficacy seemed to decline dramatically after 20 days but differences between sprayers and location in the canopy did not affect ability of larvae to bore into the apples. One interesting and unexpected observation was larval mortality on untreated foliage. We had set up the experiment so that drift between plots would be minimized. However, commercial applications of Guthion were being made nearby in other parts of the orchard. Furthermore, residues left from the use of carbaryl (Sevin) as a fruit-thinning agent seemed to cause some larval mortality. This observation suggests the hypothesis that a grower who does not use insecticides but is surrounded by neighbors using them may reap some insect control benefits from either drifting residues or at least the reduction in the area wide codling moth population. This hypothesis may be worth further investigation considering the increasing numbers of certified organic fruit growers among the more conventional growers. We are continuing to determine whether reduced application rates can be just as efficacious as the label rates. One cautionary note is that some pesticide products may have strict prohibitions against using less than the label prescribed rate. However, many products do not have such proscriptions. These pesticides should be candidates for further research on reduced application rates. The potential cost savings could move growers from the red to the black while reducing environmental residues and worker exposure.

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To view the figures see:

<http://www.aenews.wsu.edu/May03AENews/May03AENews.htm#SprayerTech>

SPRUCING UP YOUR IPM SKILLS: PLAN NOW TO ATTACK SPRUCE APHIDS NEXT YEAR June 2003

Agrichemical and Environmental News, Issue No. 206

Todd Murray, Whatcom County IPM Project Manager, WSU

<http://www.aenews.wsu.edu/June03AENews/June03AENews.htm#SpruceAphid>

In spring, pest damage becomes evident to many people. The weather is pleasant and more attention is focused on the yard. Warm-weather pests can be observed and managed at this time of year, but cool-weather pests like silver-spotted tiger moths and green spruce aphids have already done their damage. Often people who see winter damage in the spring will try to use insecticides to solve their pest problem. Washington State University insect expert Dr. Art Antonelli refers to this as ³revenge spraying²: it won't

solve your pest problem but might make you feel better.

At our clinic in Whatcom County, we try to educate people about the fundamentals of integrated pest management when dealing with these winter/spring pests. This is a great opportunity to teach people about the importance of monitoring and timing. In the case of the spruce aphid, monitoring and management activities occur in the winter, a season most people don't associate with aphid problems.

Description

Spruce aphids (*Elatobium abietinum*) are mostly wingless, 1 to 1.5 mm long (small), olive green to very dark in color, and pear-shaped. The head end can be yellowish green with reddish eyes. They have piercing/sucking mouthparts that are, as with all aphids, directed straight downward. The spruce aphid's legs are long (well, long for a 1-mm insect) and slender. During the nymph stage, they are lighter green in color. Eggs are yellow to reddish to dark brown or black. As the eggs are only about 0.6 mm long, scouting for them can be very difficult.

Life History

If you were to read the daily planner of a spruce aphid it would look like this: suck plant juice, squirt honeydew, drop egg, suck plant juice, squirt honeydew, give birth, and so on. That's about all these aphids do, but they do these few activities with great proficiency. What makes them a little unusual is the timing of this busy schedule. The spruce aphid is also known as the winter aphid because its peak population growth occurs during the winter and it all but vanishes during the summer. Spruce aphid numbers start to build in October and continue through March, with peak numbers in late winter and early spring. There are several generations annually.

The spruce aphid is an exotic pest, meaning it is not native to the Pacific Northwest. She came to us from Europe and when she made the trip, she ditched her boyfriend; only female spruce aphids live here. They reproduce by means of a phenomenon called parthenogenesis, which basically results in a clone of the female.

Damage

Throughout the spring of 2003, our Whatcom County Cooperative Extension office received an ever-increasing number of spruce aphid samples and questions pertaining to this pest. Due to mild temperatures the past few winters, spruce aphids are a problem and are causing tree mortality. Sitka spruce (*Picea sitchensis*), Norway spruce (*Picea abies*), blue spruce (*Picea pungens*), and other ornamental and commercial spruces are attacked by this pest on North America's Pacific coast from Alaska to California. Damage may also occur, although rarely, on other conifers such as pines (*Pinus* spp.) and Douglas-fir (*Pseudotsuga menziesii*) (Forestry Canada, Forest Insect and Disease Survey, Forest Pest Leaflet No. 16, 4p).

Aphids feed on older needles and do not move to the new growth immediately

(don't worry, they will get to it by next fall). During feeding, needles may discolor and eventually turn yellow or brown. Most aphids are found on the lower end of branches toward the trunk and are usually concentrated low on the tree, but high infestations can occur everywhere. Needles die back and finally drop off the twig. After multiple years of defoliation, spruce may be seriously compromised or may perish. Mortality can happen quicker in young trees.

Management

Damage is most noticeable in the month of June. Unfortunately, IT'S TOO LATE to really solve the problem. So if you're worried about your spruce, mark your calendars and plan to get out there and start scouting early next year! How early? If you have a real problem, you might want to start as early as October. How do you scout for something so small? A good way is to get a stiff piece of white card stock and your hand lens, aka magnifying glass. Brush two branches together over the card stock and start squinting through your hand lens. The aphids will be knocked out of the branch and onto the card stock. If spruce aphids are present and you already see damage, get out your garden hose and spray down the areas with a high-pressured dose of water. This will knock the aphids off the branch, onto the ground where they will be left for dead. If you have a real problem, make this hose-down a weekly habit.

Unfortunately, this aphid has taken the high road and avoided practically every natural enemy out there. We don't have many aphid feeders active in the winter. Late season ladybugs and early season brown lacewings might make an impact, but probably not much of one.

Temperature and weather seem to regulate this aphid species. Temperatures below 15o F can be deadly for aphids, especially if prolonged. Hope for a few early frost periods next February.

According to the aforementioned Dr. Art Antonelli, a few spruce species are more resistant, including Serbian spruce (*Picea omorika*), Oriental spruce (*P. orientalis*), and Japanese/tiger tail spruce (*P. polita*). All these can live happily in our area. If you're planting new spruce trees, consider these varieties.

Chemical control can be successful in managing the spruce aphid when its populations are particularly abundant and the timing is right. Consult the Pacific Northwest Insect Management Handbook (<http://pnwpest.org/pnw/insects>) or Hortsense (<http://pep.wsu.edu/hortsense>)

for a specific recommendation. And listen to my word of warning, read the label carefully, especially if you plan on using horticultural oils or insecticidal soaps to control aphids. I didn't do this and the blue spruce I was spraying didn't look very blue after I got done with it

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Office can be reached by telephone at (360) 676-6736. For the Cooperative Extension office in your Washington State county, go to Internet URL

<http://ext.wsu.edu/locations/>.

To view photographs see:

<http://www.aenews.wsu.edu/June03AENews/June03AENews.htm#SpruceAphid>

GREEN MANURING WITH MUSTARD: IMPROVING AN OLD TECHNOLOGY

June 2003

Agrichemical and Environmental News, Issue No. 206

Andy McGuire, Agricultural Systems Educator, WSU

<http://www.aenews.wsu.edu/June03AENews/June03AENews.htm#GreenManure>

Green manuring is the tilling of fresh plant material into the soil to improve the soil and thus the growth of the following crop. It is an old technology, used by farmers since at least the 5th century BC. Immigrants brought the practice to the USA from Northern Europe and its use reached a peak in the early 1900s.

Over the past century, most farmers have replaced green manuring with the use of synthetic inorganic fertilizers. Recently, however, innovative farmers are giving this old technology a new look with mustard green manures (Figure 1). In contrast to the low input, low management green manures of the past, mustard green manures require fertilizer, irrigation, and intensive management. They require a current understanding of soil ecology, soil-borne pests, plant biochemistry, and breeding and screening techniques. And unlike synthetic fertilizers, they can improve the soil's physical, chemical, and biological qualities.

These multiple benefits are attracting an increasing number of farmers in the Columbia Basin of Washington (Figure 2). They are using mustard green manures, mainly before potatoes, to improve their soils and thereby manage soil-borne pests, control wind erosion, increase infiltration, improve crop yields, and they hope, increase profits.

Up through the 1940s, green manure research was focused on improving the soil's physical characteristics and ability to supply nutrients to crops. But as synthetic fertilizers predominated, green manure research faded. In the late 1980s, researchers in the Pacific Northwest began to look again at green manures, but now for soil-borne pest control. Nematodes (Mojtahedi et al. 1993), weeds (Boydston and Hang 1995), and soil-borne diseases (Davis et al. 1994, 1996) were all targets of this research, done mainly to improve potato production. Sudangrass, already used in Washington as a cover crop before potatoes, was evaluated, but so were less familiar crops like rapeseed, oilseed radish, and mustard.

Dale Gies' Cropping System

The use of mustard green manures by Columbia Basin farmers can be traced to sugarbeet research done in Idaho in the early 1990s. Several varieties of white mustard (*Sinapis alba*) and oilseed radish were imported for testing as trap crops of the sugarbeet cyst nematode. One of these mustard varieties, Martigena, made its way into the hands of several Columbia Basin farmers who were trying it out as a green manure in irrigated crop rotations. One of these farmers was Dale Gies.

Gies, who farms just south of Moses Lake, took several years to develop his unique cropping system, a profile of which is available on the Internet at http://grant-adams.wsu.edu/agriculture/covercrops/pubs/System_profile-Gies.pdf. This system is designed around a two-year rotation of wheat followed by potatoes, with a mustard green manure planted after wheat harvest and incorporated in late October (Figure 3). Reduced tillage, careful water use, and good nutrient management practices are also important system components. Using this system, Gies found he could successfully grow potatoes every other year on the same field, which is no small feat. The Norkotah potatoes that he grows are very susceptible to the soil-borne pathogen *Verticillium dahliae*. This fungus causes potato early dying complex, which is normally controlled with longer rotations (at least three years between potato crops) and with soil fumigation before planting the potatoes. But Gies, in spite of his short rotation, was harvesting above-average yields. He also noticed improvements in his soil. In 1999, Gies began working with Washington State University (WSU) to understand these observations and refine these techniques.

In the past four years of on-farm research, we at WSU have measured improvements in soil quality and conducted fumigant replacement trials in Gies' fields. (Until 2001, he still fumigated before planting potatoes, but experimented with omitting the fumigant in parts of fields. In those areas he saw evidence that fumigation might not be necessary in his system). We have also worked to understand and improve the use of mustard green manures. The remainder of this article is a description of this work.

On-Farm Research

Improved soil quality. Soil quality is measured by specific attributes such as infiltration, soil respiration, bulk density, and aggregation; optimal levels of these attributes contribute to soil health. A healthy soil is one that will support crop growth without soil degradation or harm to the surrounding environment.

Infiltration is the process of water entering the soil. The rate of infiltration is important in irrigated agriculture, especially where center pivot irrigation is used. In these systems, the water application rate at the outside of the circles is often higher than the infiltration rate of the soil. This can result in runoff and ponding in low areas, which can lead to increased incidence of root-rot diseases. Where fertilizers and pesticides

are being applied through the water (chemigation), high infiltration rates allow the chemicals to stay where they fall. Good infiltration is also correlated with good aeration, which also can reduce soil-borne disease problems.

Green manures can increase infiltration rates, but the effect is not direct. It begins, as with many green manure effects, with the addition of organic matter to the soil. As soil microorganisms digest this organic matter, they produce various substances called soil glues. These glues bond soil particles together into stable aggregates, or soil "crumbs," which allow water to move more quickly into the soil.

We have measured infiltration on adjacent fields having similar soil textures. One was managed under the Gies cropping system. The other was in a rotation more typical of the Columbia Basin, with no green manures.

Infiltration rates (Table 1) were generally much greater under the Gies cropping system. One exception was after potato harvest on the Gies field and sugarbeet harvest on the adjacent field (2000). Infiltration rates on both fields were measured on soils that had been fluffed up during harvest. In this condition, the infiltration rate for the first inch of applied water was lower in the Gies field than in the adjacent field. However, the situation was reversed when a second inch of water was applied. We believe that the aggregates in the field not receiving green manures were not stable in water. After the first inch of water was applied, they broke down and sealed the soil. Infiltration in the Gies soil was stable, even when a third inch of water was applied. This difference in aggregate stability of the soils was confirmed in later measurements (Figure 4).

Reduced Wind Erosion. Another benefit of increased aggregation due to green manures is reduced wind erosion. Farmers in the Columbia Basin have observed this in fields receiving green manures. Research to confirm their observations is on-going; check for new research results at the WSU Cooperative Extension, Grant-Adams Area website: <http://grant-adams.wsu.edu/>.

Improved Nutrient Cycling/Availability of Nutrients. Mustard green manures can improve nutrient cycling by taking up nutrients that might otherwise be lost to leaching. When a green manure is returned to the soil, much of the nitrogen that the mustard takes up, whether from fertilizer or residual from the previous crop, will become available to following crops. This is also true for other nutrients. As the saying goes, "feed the soil and the soil will feed the plants." A rule of thumb for green manures incorporated the same season as the following crop is that 50% of the nitrogen in the green manure will be available. The actual amount depends on the plant composition, soil temperature, soil moisture, and losses due to leaching. Leaching of nutrients released during decomposition is a risk with mustard green manures because they are incorporated in the fall. This risk may be reduced when the mustard green manure is incorporated with a large amount of

wheat straw, which will tend to tie up any available nitrogen in the soil. To do this, farmers must direct seed the mustard through standing wheat stubble. If, however, the wheat straw is incorporated before mustard planting, it will tie up nitrogen and more fertilizer will be required to grow the mustard.

Spring incorporation would lessen the risk of leaching, but farmers prefer to incorporate in the fall for several reasons. First, they do not want to have to deal with a green manure in the spring when there are many other things to do. Second, there is less risk of damage from any soil-borne pathogens that might have been stimulated by the green manure. Finally, because mustards will not always survive winters in this region, a spring incorporation of dead plants would not give them the green manure effects that are important for pest control (see Green Manure Effects, below). Green manures can also increase nutrient availability through weathering of soil mineral components. This weathering may be caused by the production of acids by microorganisms during the decomposition of the green manure. Research on the nutrient cycling of mustard green manure crops is beginning this year.

Improved Management of Soil-Borne Pests. Much of the renewed interest in green manures is focused on their potential to help control soil-borne pests such as fungal pathogens and nematodes. Often, these pests cannot be controlled well with pesticides and when they can, as with soil fumigants, it is expensive to do so. Mustard green manures offer farmers a management tool for some of these pests.

The fumigant metam sodium is widely used in Columbia Basin potato production for the control of *Verticillium dahliae*, a major cause of potato early dying complex. Without such control, yield losses of up to 30% can be expected. We conducted fumigant replacement trials to see whether such losses would occur in the Gies wheat/mustard-potato rotation if we did not apply metam sodium. Three trials were conducted over two years (1999 and 2000) on loamy sand and sandy loam soils. Mustard green manures were fall-incorporated and potatoes (cv. Russet Norkotah), with and without metam sodium, were planted the following spring. The results (Figure 5) show that the fumigant did not increase potato yields over those produced without fumigant. Gies could have saved the money spent on the fumigant and harvested the same amount of potatoes.

Although the replacement of fumigant with mustard works for Gies, his system is quite different from that of other potato farmers in Washington. While Gies grows a short-season potato (Norkotah) for the fresh market, 90% of Washington's potato farmers grow longer-season potatoes for processing. Processors require these farmers to grow crops other than potatoes for at least three years before growing potatoes, so the short two-year rotation that Gies uses is not feasible for them. Therefore, in 2001, we began to

investigate whether we would find the same results with these longer-season potatoes in longer rotations.

Our first results (Figure 6) indicate that it is possible to replace metam sodium with mustard green manures in long-season potatoes. Specific gravity (referenced in the figure) is a measurement of the amount of solids in a potato. Processors want high specific gravities to improve their product quality.

While this first trial gave positive results, other fields (unreplicated plots) on the same farm showed lower yields where the fumigant had been omitted. We are now trying to determine whether these conflicting results are due to differences in initial disease pressure, soil properties, management of the mustard, or other factors.

Pest Control Mechanisms

The effects of mustard green manures are the result of multiple mechanisms. Because it is difficult to observe these mechanisms in the soil, our strategy has been to identify, as best we can, the primary mechanisms and the green manure attributes that enhance these mechanisms. We can then manage the mustard to produce those attributes.

In this strategy, we have focused on three groups of mechanisms that stem from different aspects of the mustard green manure:

- crop rotation effects from growing the crop,
- green manure effects from tilling fresh plant material into the soil, and
- biofumigation effects from the chemicals in the green manure.

Crop Rotation Effects. Before advances in soil science and microbiology, many effects of green manures were assumed to be the result of simple crop rotation. Rotating diverse crops can reduce pest problems by changing the environmental conditions in the field. These changing conditions disrupt pest life cycles. In general, rotating crops with different planting dates (spring vs. fall), different growing habits (annual vs. perennial, tall vs. short, fibrous vs. tap rooted), or different susceptibility to pests (grasses vs. broadleaves) helps prevent any one pest from becoming a problem.

The Columbia root-knot nematode is a serious pest in potatoes that can be reduced by rotating non-host crops. Mustards, depending on the study, have been classified as non-hosts, poor hosts, or moderate hosts of this nematode. Although a mustard green manure is probably not grown long enough to reduce nematode number by this mechanism, a poor/non-host status would keep the nematode populations from increasing. These nematodes, however, can increase on weeds in the mustard. Therefore, some farmers choose to control volunteer wheat and other weeds in their mustard crop with selective herbicides.

One rotation-related concern of Columbia Basin farmers is that the mustard could cross-pollinate with existing Brassica seed crops. The August planting

date of most mustard green manures limits this risk, but farmers growing mustard still have the responsibility to prevent cross-pollination by either incorporating or otherwise killing plants which survive in fields or field borders.

Green Manure Effects. Incorporating fresh, green plant material into soil changes the soil's biology through a transfer of energy. Energy from the sun, stored in plants, is made available to soil microorganisms through green manuring. As these fungi and bacteria digest the plants, certain species (usually beneficial) increase in number because they are best suited to use this energy. The increased numbers of these beneficial species can then suppress pathogens through a number of potential mechanisms such as the interference of chemical signaling between the plant and pathogen, predation, parasitism, and competitive exclusion. Competitive exclusion is the mechanism that occurs when the increased number of beneficial microorganisms out-compete pathogens for location in the area just outside roots of the following potatoes.

There is evidence some green manures are better "food" for the soil than others. Certain Brassica green manures have been shown to increase the total fungal populations while reducing those of *Pythium* (Lazzeri and Manici 2001). In the same study, a non-Brassica green manure resulted in increases in both total fungal and *Pythium* populations. The differing results may be due to chemicals in the Brassica crops (see Biofumigation Effects, below). One of the most beneficial green manure effects could be the building of suppressive soils. These are soils that should have a disease problem, but do not because certain microorganisms are suppressing the disease-causing agents, whether fungi, bacteria, or nematodes (Cook and Baker 1983). Suppressive soils can result from growing the same crop continuously for many years. Under this scenario, disease pressure increases at first, but eventually decreases and remains at low levels. Green manures may be a more practical way to build suppressive soils. Different green manure crops have been evaluated for their ability to produce soils suppressive to *Verticillium*, common scab, and other soil-borne diseases (L.L. Kinkel, data not yet published). Canola, sudangrass, and buckwheat were found to be better green manures than other crops in creating suppressive soils (mustard was not tested).

Although the effects of green manures usually favor beneficial microorganisms, there can be short-term increases in disease-causing *Pythium*, *Fusarium*, and other fungi immediately after incorporation. This increase does not usually last long, but farmers should wait from two to four weeks after incorporating a green manure before planting a crop.

Biofumigation Effects (Allelopathy). Biofumigation is the name coined by Kirkegaard and Sarwar (1998) to describe the effects of the chemicals produced by a Brassica green manure crop. It is one type of allelopathy, the

chemical inhibition of one species by another.

Plants in the Brassica family, such as rapeseed, broccoli, cabbage, and mustard, produce compounds called glucosinolates in their roots and shoots. They also produce an enzyme called myrosinase, which is normally separated from the glucosinolates. When the plant cells are damaged, by an insect or by a farmer chopping a green manure crop, the glucosinolates and the myrosinase come together. A reaction takes place that produces a mixture of other compounds (Figure 7). Some of these resulting compounds are toxic to soil fungi, nematodes, and even weed seeds. These are the same chemicals that make your nose burn when you eat hot Chinese mustard.

One class of these compounds, called isothiocyanates, are very similar to synthetic fumigants, hence the name biofumigation. The active compound in the fumigant metam sodium is methyl-isothiocyanate.

However, biofumigation is not as simple as using metam sodium. There are over 100 different glucosinolates, which produce different degradation products that have different effects on specific soil-borne pests. Different mustard species produce different glucosinolates. Within a species, roots may produce different glucosinolates than shoots. Finally, glucosinolate concentrations differ according to plant part, age, health, and nutrition. Despite this complexity, the potential exists to reduce pest populations in the soil through this mechanism (Brown and Morra 1997).

Effects on Soil-Borne Pests

Verticillium and Other Soil-Borne Fungal Pests. As mentioned before, Verticillium is a serious pest in potatoes and controlling it with fumigants is expensive. In the 1990s, it was found that a sorghum-sudangrass green manure could suppress Verticillium as well as fumigants (Davis 1994). Later research showed that other grass green manures such as barley, wheat, and sweet corn also suppressed Verticillium. To achieve this effect, it was necessary to produce lots of plant material (four to five tons of dry matter per acre) and incorporate it green. The incorporation of dry crop residues, even of mustard residues, does not provide the same beneficial effects in terms of pathogen suppression as a green manure. This may be due to competitive exclusion, but whatever the mechanism, it is not unique to mustard green manures, and therefore is not due to biofumigation.

Other soil-borne fungal diseases such as silver scurf (Vaughn 1998) and white mold (Smolinska and Horbowicz 1999; Pung 2002) might also be suppressed through biofumigation or a combination of these mechanisms.

Nematodes. It is not clear which mechanism is responsible for reducing the populations of parasitic nematodes. Growing a poor or non-host crop will help, but biofumigation and the green manure effects are probably also involved. Whatever the mechanism, rapeseed, sorghum-sudangrass, and white mustard green manures have all been shown to reduce the numbers of Columbia root-knot nematode by up to 90% (Mojtehedi et al. 1993). Unfortunately, this

suppression is not sufficient to meet quality standards for processing potatoes. Therefore, in fields infested with the Columbia root-knot nematode, mustard green manures must be combined with fumigants or contact nematicides to obtain the necessary control.

Weeds. The rapid growth of mustard can shade weeds and reduce their growth. After incorporation, biofumigation is probably the mechanism that later suppresses germination of small weed seeds (Al-Khatib and Boydston 1999). Crops seeded too soon after the incorporation of a Brassica crop can also be damaged.

Mustard Management Strategies

Certain attributes of a mustard green manure enhance its effectiveness in improving soil quality and controlling pests. Farmers can manage the mustard to produce these attributes if they have the information they need to make good decisions. Table 2 shows these desired attributes, the mechanisms that they affect, the related management decisions, and the information available to help farmers make these decisions.

Cost

The cost of a mustard green manure, as grown on the Gies farm, is shown in Table 3. Because a green manure is used to improve the crop that follows, its cost should be viewed as part of the production costs for that crop.

Increases in crop yield and quality and potential decreases in nitrogen or pesticide needs will all be factors in determining the worth of a green manure. In addition, the value of improved soil quality, in both the short and long term, though difficult to estimate, should be considered.

The calculation is more straightforward where the mustard green manure replaces a fumigant. Where this is possible, substantial savings can be realized.

Green Manures in Cropping Systems

Mustard green manuring is not an isolated practice. It must be integrated into a cropping system to produce the maximum benefits. Systems that reduce tillage, avoid compaction, rotate crops, and control erosion will help maintain soil quality gains that come through green manure use. Good management of water and soil fertility will ensure that gains in soil-borne pest control will not be lost to waterlogged soils or over-fertilization.

The Future of Green Manuring

The demand for food, and thus the need for quality soils, will only increase. Although improved synthetic fertilizers and pesticides will continue to be important, they, by themselves, do not build soil quality. It will be through green manuring and other practices that increase or conserve soil organic matter that we will maintain and build our soils, just as it has always been. What will change is the attention we pay to green manuring. If we continue to improve this old technology by applying our growing knowledge of soil ecology, plant pathology, plant breeding, biochemistry,

horticulture, and agronomy there are many possibilities:

Crops bred for green manure use.

Rotation of green manure crops.

Prescription green manure blends.

Genetically modified green manure crops.

Any or all of these could be the future of green manuring if we choose to pursue them.

In 1927, Pieters wrote in his book *Green Manuring: Principles and Practice*, "Much is known of what goes on in the soil when organic matter is added, but much still remains to be learned." While we have added much to our cumulative knowledge since then, the same could be said today. The soil still has secrets. There are still processes within plants that we do not understand. If we continue to increase our knowledge of both the soil and plants, green manuring could again become a common practice.

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http://grant-adams.wsu.edu/agriculture/covercrops/green_manures/index.htm.

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To view tables, figures, acknowledgements and references see:

<http://www.aenews.wsu.edu/June03AENews/June03AENews.htm#GreenManure>

CULTIVATING BIOLOGICAL CONNECTIONS: ORGANIC/BIOAG SYMPOSIUM OPENS DOORS

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<http://www.aenews.wsu.edu/Apr03AENews/Apr03AENews.htm#BioAgSymposium>

One of the fastest growing segments of agriculture in the United States is organic farming. For the past decade, the organic food industry has been growing at a rate of 20 to 30% annually, with a commensurate increase in land farmed under certified organic management and an increasing need for research and education on organic farming practices and systems. While certified organic farming is now specifically defined by the USDA National Organic Standards, many practices that are central to organic farming are being incorporated by farmers into their ³conventional² systems to help meet economic and environmental goals. Similarly, research developments in ³conventional² agriculture on biointensive IPM and biological control, for example, are expanding and are of direct benefit to organic producers. Thus, the commonality between ³organic² and ³conventional² is increasing.

At Washington State University, the Center for Sustaining Agriculture and Natural Resources (CSANR) is developing a research and education program on Biologically Intensive and Organic Agriculture (BIOAg) to encourage this common ground that can help all producers while clearly addressing public concern for environmental stewardship. The need for a more sustainable agriculture will require greater reliance on biological processes that are renewable, that are non-polluting, and that provide multiple benefits for farmers and society; hence the term ³biologically intensive.² Organic farming is one of the better developed examples of this concept. Land grant universities such as Washington State University (WSU) are helping to meet the growing need for this type of information.

Seeds of the Symposium

A common misperception in the Pacific Northwest is that the land grant universities are not involved in organic farming research. In 2001, CSANR conducted an informal email survey of WSU agriculture faculty to determine the kinds of organic or organic-related projects, if any, they had completed, were underway, or were planned. Over 50 faculty members responded to the survey and reported 90 projects that related to organic agriculture. In October 2001, the CSANR hosted a day-long meeting where 50 faculty participated to plan organic farming research and education at WSU. The group proposed a symposium as a next step to bring researchers and their projects together with growers, educators, and consultants. Two goals were identified:

1. make the public aware of the array of relevant organic farming research underway, and
2. provide an opportunity for researchers and end users to meet, explore common ground, and plan future collaboration.

Planning for the Northwest Symposium on Organic and Biologically Intensive Farming became a team effort involving WSU, Washington Tilth Producers (a statewide sustainable/organic farming group), Oregon State University, and Oregon Tilth. The Symposium date was set to occur the day before the annual Tilth Producers Conference to provide as much crossover of participants as possible. A planning group consisting of university, non-governmental organization (NGO), grower, and industry representatives designed an agenda consisting of presentations on four key topics related to BIOAg, followed by a two-hour interactive poster session. The topics were soils, seeds and genes, pest management, and system studies. Speakers were selected to represent leading edge research. More practical presentations on organic farming methods occurred during the Tilth Conference itself. Funding for the event was provided by registration fees, an EPA mini-grant, CSANR, Western SARE, and contributions from industry sponsors.

Fruits of the Symposium

The Symposium succeeded in meeting both its goals. More than 220 people

attended the event. About half the participants were growers, a quarter were researchers and extension agents, and a quarter were industry and agency representatives. Forty-eight posters were presented. Thus, a large number of people were exposed to the significant amount of research underway relevant to organic farming and biointensive agriculture. The poster session provided a great opportunity for interaction, confirmed by responses on the evaluation forms. Each poster author submitted a one-page summary. These were bound into a proceedings called ³Cultivating Biological Connections² and given to participants for future reference (this document is available on-line at <http://csanr.wsu.edu/programs/Proceedings.pdf>).

Branches of the Symposium

In the oral presentations, Chris Koopmans, from the Louis Bolk Institute for Organic Farming in the Netherlands, described his work on field measurement and modeling to predict soil nitrogen dynamics on organic farms. He is working with the NDICEA (Nitrogen Dynamics in Crop Rotations in Ecological Agriculture) simulation model that tracks soil nitrogen, organic matter dynamics, and crop uptake. The goal is to identify the nitrogen release characteristics of various organic fertilizers and use the model to best match fertilizer type and timing with crop need while minimizing residual nitrogen at the end of the growing season.

Steve Jones, WSU wheat breeder, highlighted his organic wheat breeding and perennial wheat development projects. His group is screening over 160 historical cultivars previously grown in the Pacific Northwest for traits of potential benefit to organic farmers, such as emergence rate, height, and resilience to mechanical weeding. John Haapala introduced the Farmer Cooperative Genome Project that he initiated, with organic growers across the country evaluating vegetable germplasm in cooperation with Cornell University Vegetable Breeders Institute. Results include powdery mildew resistance for squash and cucumbers, blight-resistant tomatoes, and a new organic broccoli breeding effort at Oregon State University.

Advances in biointensive IPM of insects in tree fruit were presented by Ted Alway, including area-wide mating disruption and the role of surrounding habitat for natural enemies. His Wenatchee Valley Pear IPM project illustrated potential lower cost and better pest control with an ³organic² insect pest management program. Matt Liebman, Iowa State University agronomist, illustrated his years of work on integrating crop, soil, and weed management to make systems more ³weed suppressive.² He uses the term ³many little hammers² to illustrate the need for multiple strategies that each deliver small gains in weed control rather than a ³big hammer² replacement for herbicides.

Two contrasting farming systems studies were also presented. A field-scale replicated orchard systems experiment led by WSU's John Reganold that included conventional, organic, and integrated production, has shown the

organic system to have tree growth, fruit yield, and quality equal to the conventional system. Using the ³Responsible Choice² environmental impact tool, he compared the three production systems. The Responsible Choice method assigns a numerical value to a range of factors pertaining to the pesticide such as acute LD50, effect on beneficials, and solubility, then combines these to arrive at a score. Using this method, Reganold found the organic production system to have the lowest impact and the conventional the highest.

The other farming system study was presented by Henning Sehmsdorf who introduced his integrated small farm where he is monitoring nutrient, energy, labor, and cash flows in his quest for a highly productive and renewable farm model. He and his colleagues used emergy analysis to evaluate ecological sustainability on the farm. (Emergy is defined as the available energy of one kind previously used up directly and indirectly in the production of a product) Vegetable, fruit and pork production required large amounts of imported resources in relation to the amount of locally available emergy that those sub-systems received from the environment. In contrast, beef, lamb, and grain production relied much more on local resources.

Offshoots of the Symposium

Future symposia are envisioned as a continuation of this initial cooperative effort. Rather than a broad range of topics, they will likely be organized around priority issues facing BIOAg, such as the potential convergence of organic farming and direct seeding. The first Symposium set in motion many new ³biological connections² among the people who will shape a more sustainable agriculture in the region.

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