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CORN

MANAGING RESISTANCE TO BT CORN HYBRIDS

By Ric Bessin

Interest in Bt corn and adoption of varieties by growers has been remarkable. So much so, that a large portion of the 1999 corn acreage in Kentucky probably will be planted with Bt hybrids. As the acreage increases, so does the potential for corn borers developing resistance to the Bt toxin. Now is the time to study resistance management plans, BEFORE THE PEST DEVELOPS RESISTANCE!

Protecting against the development of insect resistance IS the responsibility of ALL producers who use these hybrids. This must not be taken lightly. Development of resistance by corn borers to these hybrids is a real threat. This means that each producer using these new hybrids must have a plan.

Currently, the only effective resistance management plan is to plant some acreage with non- Bt hybrids. This is called the refuge strategy. In it, non-Bt acreage on each farm serves as a refuge, allowing some Bt-susceptible corn borers to survive. Then, if a rare resistant corn borer were able to survive on a Bt-corn plant, it would most likely mate with a susceptible corn borer. Corn borers produced from this mating would still be moderately susceptible, and would not be able to survive on the Bt-hybrids. This strategy tries to prevent mating among Bt-resistant corn borers.

With the refuge strategy, a portion of their corn crop must be planted with non-Bt hybrids. Most universities recommend that at least 20 to 30% of the total corn acreage on each farm must be planted with these varieties. Thus, the upper limit for Bt corn acreage on any farm would be 70 to 80%.

The arrangement of Bt and non-Bt hybrids fields also is important. These plantings need to be arranged so that any moths that happen to emerge from Bt hybrids are most likely to mate with moths from the non-Bt hybrids. Refuges should be planted in adjacent fields or as a block to one side of the Bt corn in the same field.

A few producers have considered using Bt corn in some of the planter boxes and non-Bt corn in the others to plant alternating strips through fields. This is not a good idea. Producers should not plant refuge strips in Bt corn fields. This fosters the development of resistance and makes management of these fields much more difficult. For example, if the non-Bt corn refuge reaches threshold for corn borer control, it would be impractical to treat the refuge with insecticides if it is planted as strips in a much larger field. It would also be a waste of money to spray the Bt corn for corn borer control.

Also, some corn hybrids have stacked genes for corn borer control as well as herbicide tolerance (Liberty, Roundup, etc.). To avoid using the wrong herbicide on the wrong hybrid, growers should avoid planting these hybrids in strips.

Producers should not mix Bt and non-Bt seed. This may encourage the more rapid development of resistance. Because corn borers do occasionally move from plant to plant, mixing seed or planting strips may allow some partially resistant individuals to escape a lethal dose.

The refuge needs to be planted at the same time the Bt corn is planted. For example, if Bt corn is planted on three dates, each ten days apart, then refuges need to be planted on each of those planting dates, as well. The refuge should be planted with hybrids that are agronomically similar to the Bt corn and planted as close to the Bt corn as possible. The refuges should receive the same fertility and irrigation inputs as the Bt corn. Reducing inputs and putting the refuge on marginal land may reduce its effectiveness.

How Do You Know If Corn Borer Resistance Is a Problem? Simply finding a few transgenic corn plants with corn borer damage, or even a few plants with extensive damage, does not mean that the corn borers are resistant. In any bushel of Bt-corn seed, there will be some plants that express only low levels of the Bt endotoxin or some that may not express the Bt-endotoxin at all (this may be as high as 2 to 5% of the seed).

Determining whether or not corn borers are resistant to Bt is very difficult, particularly in the early stages of development. Widespread economic damage throughout the field would be an indication of resistance, but resistance can only be confirmed through laboratory analysis. Producers growing Bt-hybrids still need to monitor their fields for corn borers in order to determine that the Bt- hybrids are controlling corn borers. If corn borer resistance is suspected in Bt corn, producers should contact their local county extension service office and their seed corn representative.

When a producer has decided that a Bt-hybrid is needed, how should this hybrid be positioned on the farm? Corn borers can attack corn planted at any time, but usually first generation damage is most severe in early planted corn. Late planted corn is more severely damaged by second generation European corn borer and southwestern corn borer. So, growers may want to select Bt corn for early or late plantings if they have had problems with corn borers in the past.

Later plantings are more likely to have tip damage from corn earworm and economic infestations of fall armyworm. Bt hybrids that provide full season control have reduced damage by corn earworm and fall armyworm by 50% to 70%. Growers using Bt-hybrids with later plantings still need to monitor for fall armyworm and treat if necessary.

GREENHOUSE

FUSARIUM CROWN AND ROOT ROT OF GREENHOUSE TOMATOES
By William Nesmith

Fusarium crown and root rot (FCRR) is becoming more common in greenhouse tomato production in Kentucky. Even though we sometimes find low levels of FCRR in the first year of operation, it is mainly a problem in established operations. Houses that are being used for tobacco transplants in the spring and tomato fruits in the fall have had the greatest problems.

A wide range of symptoms are associated with FCRR, but a general yellowing moving from the bottom up on individual plants and stunting are usually involved. In time, wilting is usually present and often basal stem cankers appear. Examination of the roots of plants with FCRR should reveal that the entire root system is involved, with a brownish rot of the cortex and xylem that usually extends into the base of the stem.

Fusarium oxysporum f.sp. *radicis-lycopersici* is the fungus that causes this disease. This fungus is an excellent colonizer of the soilless mixes being used in bag-culture-systems. It develops best in cool soils, below 70 F. We see the greatest problems in systems where little heat is being used, or following extreme cold snaps. The impact of FCRR is also made worse when the plants are stressed, even though, it is clear that the infections have been present much earlier.

Control programs should be put in place before planting, because there are no rescue treatments, but once the disease is present in a house, avoiding stress is an important part of minimizing losses. Aggressive sanitation programs are very important, starting with a very clean house and all the items to

be used. The worse cases of this disease in Kentucky have been associated with attempts to reuse items without sanitizing them, especially items that come in direct contact with the soil mix. Tomato cultivars resistant to FCRR offer the best hope for control in operations with serious problems. The following are some varieties with resistance: Trend, Trust, Medallion, Match, Switch, and Blitz. However, we have limited experience with some of these varieties in Kentucky, so growers probably should initially try them on a small scale. Do not confuse resistance to Fusarium wilt with resistance to FCRR; they are two different diseases.

FCRR also occurs in field plantings of tomatoes, with more and more cases observed each year. We suspect this is in-part connected to increased use of locally grown transplants being produced under poor sanitation. In addition, we are finding field cases of similar diseases associated with bell peppers, eggplant, and tobacco, all tied to locally produced greenhouse-transplants.

BIOLOGICAL CONTROL AGENTS FOR GREENHOUSE CROP DISEASE CONTROL

By John Hartman

Growers of ornamentals and bedding plants in the greenhouse often ask for alternatives to chemicals for control of soilborne diseases. While attending a recent meeting on diseases of ornamentals, the topic of biological controls (biocontrols) for soilborne diseases in the greenhouse was discussed. Three commercial products formulated from naturally-occurring species of fungi are registered as biocontrols for greenhouse crop diseases (Notice that tobacco transplants are not specifically mentioned.):

- SoilGard is used to control greenhouse ornamental and food crop plant damping-off and root rot diseases caused by *Pythium* and *Rhizoctonia*, two important soilborne pathogens. SoilGard (Thermo Trilogy 7379 Route 32, Columbia, MD 21044; Tel. 410/531-4582) is a formulation of the fungus *Gliocladium viridens* GL21.
- Root Shield and T-22 Planter Box are formulations of *Trichoderma harzianum* T-22 which are used to control Soilborne diseases of greenhouse ornamentals, nursery trees and shrubs, transplants, cabbage, tomatoes and cucumbers, caused by *Pythium*, *Rhizoctonia* and *Fusarium*.
- Promote (J.H. Biotech, 4951 Olivas Park Drive, Ventura, CA 93003; Tel. 805/650-8933) is a formulation of *Trichoderma harzianum* and *T. viride* for control of *Pythium*, *Rhizoctonia* and *Fusarium* in greenhouse crops, nursery transplants, and seedlings.

These biocontrols are used preventively, normally being incorporated into the potting mix used to grow the greenhouse crop or applied as soil drenches. One of the criticisms of biocontrol products is that they are reported to work inconsistently, being very effective for one grower or one circumstance, but not for another. Thus, for Kentucky greenhouse growers wishing to try biocontrols, the best approach would be to try the biocontrols in just a part of their crop and see if they work well in their circumstances before committing their entire production to this technique.

At the recent conference on ornamental diseases, a horticulturist from the Van Wingerden company in North Carolina explained how they use this cautious "try a little of it and see" method for evaluating these products. Several of us later visited the greenhouse and saw how they were managing diseases while at the same time recycling all of their run-off from irrigation water, pesticide, and fertilizer applications. The greenhouses are carefully engineered to provide water and fertilizer to potted plants through a "flood and flow" system which minimizes the length of time that soils are saturated. It is a system that could have potential for spreading diseases and contaminating water so it is important that biological and cultural controls work well.

<u>Biological control materials for some other sites</u>. There are several additional biocontrol agents registered for non-greenhouse crops.

- Galltrol-A (AgBioChem, Inc., 3 Fleetwood Ct., Orinda, CA 94563; Tel. 510/254-0789) and Norbac 84C (New BioProducts, Inc., 4737 NW Elmwood Dr., Corvallis, OR 97330; Tel. 503/752-2045) are formulations of *Agrobacterium radiobacter* K84 which are used in the nursery on fruit and nut trees, roses, and ornamentals to control crown gall disease caused by *Agrobacterium tumefaciens*.
- BlightBan A506 (Plant Health Technologies, 2563 E. Bergerson St. Boise, ID 83706; Tel 208/389-7265) is a formulation of *Pseudomonas syringae* used to control fire blight of pome fruits and to prevent frost damage of selected

fruits and vegetables.

- AQ10 Biofungicide (Ecogen, Inc., 2005 Cabot Blvd. West, Langhorne, PA 19074; Tel. 215/757-1590) is formulated from the fungus *Ampelomyces quisqualis* M-10 for control of powdery mildew of ornamentals, apples, grapes, cucurbits, and tomatoes.
- Kodiak and Epic (Gustafson, Inc., PO Box 660065, Dallas, TX 75266, USA; Tel. 214/985-8877) are formulations of *Bacillus subtilis* GB03 which are used on cotton and legumes to control damping-off diseases caused by *Rhizoctonia, Fusarium, Alternaria,* and *Aspergillus.*
- Bio-Save 100 and 110 (EcoScience Cort., 377 Plantation St., Worcester, MA 01605; Tel. 508/7540300) are formulations of *Pseudomonas syringae* that are used on citrus and pome fruits to control post-harvest fruit rots caused by *Botrytis, Penicillium,* and *Mucor.*
- Mycostop (Ag Bio Development, Inc., 9915 Raleigh St., Westminster, CO 80030; Tel. 303/469-9221) is a formulation of *Streptomyces griseoviridis* K61 which is used to control diseases of field, ornamental, and vegetable crops caused by *Fusarium, Alternaria, Phomopsis, Botrytis, Pythium,* and *Phytophthora.*

Other commercial biocontrol products available in the U.S. include Aspire for post-harvest diseases of citrus and pome fruit, Blue Circle for vegetable diseases, Deny for field crop diseases, Conquer for mushroom diseases, Intercept for vegetable and cotton diseases, System 3 for field crop diseases, and Victus for mushroom diseases. For more information on use of biological control materials for plant disease control, growers and advisors can consult the Biocontrol Products List on the internet at http://www.barc.usda.gov/psi/bpdl.html.

HOUSEHOLD

PRECAUTIONS FOR TOTAL RELEASE FOGGERS
By Lee Townsend

Total release aerosol foggers or "bug bombs" are often considered a quick fix for insect infestations in the home, such as the lady beetles that are flying now. The insecticide in these formulations kills exposed pests that are directly hit with fog particles. There is no distribution into protected areas, such as under furniture. Consumers often feel that they are "fumigating" and that most, if not all, pests within a structure will be killed. When foggers are used as the only means of control, no attention is given to sanitation or other parts of the comprehensive approach needed to thwart persistent pests.

More importantly, the aerosol propellants used in foggers typically are flammable; improper use could cause a fire or explosion. The following information on aerosol foggers is from an EPA fact sheet on these products.

There are two main points-

☞ **Use no more pesticide than necessary**

Generally, one 6-ounce or 8-ounce fogger should be sufficient for an average-size home; smaller-sized foggers are available for apartments and other smaller units.

More precisely, using no more than one ounce of product per 1,000 cubic feet of living area should significantly reduce the chance of fire and still be effective. (To calculate the volume of a living area, multiply the height, width and length of a room, and add the room volumes together. For example, an 8 foot by 10 foot by 10 foot room has a volume of 800 cubic feet.) Foggers should not be used in small, enclosed places, such as closets, cabinets, or under counters or tables.

☞ **Avoid ignition sources**

Accidents are most likely to occur if large amounts of propellant come into contact with an ignition source, such as a flame, pilot light, or a spark from an electrical appliance that cycles on and off, like a refrigerator or air conditioner. EPA recommends that the active fogger be placed at least six feet or further from all ignition sources.

The following excerpts from an AP story from a few years ago illustrate the points-

COWETA, Okla. - A woman gathered up two children, a pet bird and a puppy before setting off 18 cans of bug fogger in her mobile home. She stepped outside and the fumes exploded. The windows, door and one wall were blown out. Fortunately, no one was injured. According to the local fire chief, a pilot light probably ignited the fumes. The eighteen cans of insect fogger , found in the rubble, were enough to treat 90,000 cubic feet. The volume of the mobile home was about 6,000 cubic feet.

WHAT'S AVAILABLE TO HOMEOWNERS FOR LADY BEETLE CONTROL
By Mike Potter and Lee Townsend

The information below is from a September 14, 1998 KPN article. Active ingredient names have been

added for the home pest control products plus brand names for some of the choices available to professionals. *Note that products found on Internet searches may not be labeled in Kentucky or may not be readily available to consumers.*

Consider applying an exterior (barrier) insecticide treatment. While sealing is the more permanent way to exclude pests originating from outdoors, comprehensive pest-proofing is labor-intensive and sometimes impractical. For clients requiring an alternative, pest proofing can be supplemented by an exterior treatment with an insecticide. Homeowners will get the most for their efforts by applying longer-lasting liquid formulations containing synthetic pyrethroids e.g., Spectracide Bug Stop (tralomethrin), Ortho Home Defense System (bifenthrin) or microencapsulated, slow-release Dursban, sold at hardware/lawn and garden shops.

Apply with a pump up sprayer, hose end sprayer, etc., treating at the base of all exterior doors, garage and crawl space entrances, around foundation vents and utility openings, and up underneath siding. It may also be useful to treat around the outside perimeter of the foundation in a 2 to 6-foot-wide band along the ground, and 2-3 feet up the foundation wall.

Clients who choose not to tackle these activities may wish to hire a professional pest control firm. PCO's have other control options, such as, Demand CS, Tempo, Demon, Saga, Commodore, Talstar, and Suspend.

FIREWOOD PESTS
By Mike Potter

This is the time when most homeowners begin to burn firewood. Firewood is a source of warmth and comfort, but can also be a way for pests to enter homes. Most pests living in firewood pose no threat to people, furniture, or to the structure. Nonetheless, homeowners often become concerned when insects emerge from wood that is brought indoors and crawl or fly about the house.

Several types of pests may be found living in firewood. Termites, wood boring beetles and carpenter ants often tunnel and feed within firewood logs, *but upon emergence, usually will not infest structural wood or furniture inside the home.* Other kinds of pests simply hide or overwinter beneath the bark. Examples include centipedes, ground beetles, sowbugs, pillbugs, spiders, scorpions and wood cockroaches. Typically, these pests emerge within a few days of the wood being brought indoors. For the most part they are harmless other than by their presence.

Preventing Firewood Pests

Control of firewood pests is best accomplished by management of the firewood itself. Spraying the wood with insecticides is not necessary, effective, nor recommended and could result in harmful vapors when the wood is burned. A much better approach is to:

1. **Store firewood outdoors, only bringing in what you plan to burn immediately or within a few hours**. Storing firewood for extended periods inside the home, garage or basement allows pests developing or hiding in the wood to emerge within the structure. Firewood stored indoors can also become a harborage for rodents.

2. **Position the woodpile away from the house and off the ground.** Firewood stacked against the side of a building impedes ventilation and encourages moisture problems. Storing the wood in this manner also provides a direct, hidden avenue for termites and carpenter ants into the structure. Stacking firewood off the ground (e.g., on poles suspended between concrete blocks) increases air circulation and drying.

3. **Burn older wood first**. This shortens the time during which pest infestations can become established.

4. **Shake or knock logs together to dislodge any pests clinging to bark**. Don't forget to check bottoms of log carriers, since pests often crawl into these when logs are transported into the home. The occasional insect emerging from firewood can easily be eliminated using a broom or a vacuum cleaner.

LIVESTOCK

HORSE BOTS
By Lee Townsend

The first hard frost or two in the fall finishes off some insects and end the potential for infestation until next spring. Horse bots fall into this category. They are honey bee-sized flies that dart around and glue their tiny eggs or nits to body hairs of horses, donkeys and mules. The fast movements of these

flies can frighten animals. Horses also can injury themselves as they attempt to relieve the irritation from burrowing activities of newly hatched bots. In addition, most of the larval or bot stage of the fly is spent as an internal parasite where it can cause serious problems.

There are three species of horse bots. Their life cycles essentially vary only in where they attach their yellow to gray eggs to the host. Common horse bot eggs most often are attached to hairs on the fore legs but can be found on the outside of the legs, the mane and on the flanks. Throat bot eggs are attached to the long hairs beneath the jaws. Nose bot eggs are stuck to hairs on the upper and lower lips. It is easy to see how horses can be spooked by flies buzzing at these areas and may injure themselves or people working or riding them at the time. Depending on the species, females deposit from a few hundred to 1,000 eggs during their life time.

Bot eggs hatch after a 2- to 5-day incubation period, often stimulated by warmth and moisture from the animal's tongue. Newly hatched bot larvae enter or are taken into the mouth. They spend about 3 weeks in soft tissue of the lips, gums, or tongue. The bots then migrate to the stomach or small intestine where they use sharp mouth hooks to attach to the lining of the organ. Bots can damage the lining of the stomach or small intestine, interfere with the passage of food, or cause other gastrointestinal disorders. They spend about 7 months there before passing out in the feces. The mature larvae enter the soil below the dung pile and pupate. In 2 weeks to 2 months, depending upon the season, they emerge as adults.

The adults do not have functional mouthparts so they cannot feed. Females go to horses only to lay their eggs. Most of the egg- laying is done during August and September. A hard frost is needed to assure the end of fly season each year.

CONTROL

While bot flies may or may not be noticed around horses, it is easy to look for nits, or eggs, on the animal's coat. Virtually all horses in Kentucky are likely to be infested. Most of the pest life cycle occurs in the horse. Consequently, an insecticide, applied internally, is necessary to provide effective control. Check product labels carefully, all equine deworming drugs do not necessarily affect horse bots. Before purchasing any product, read the pest list on the label and note any precautions regarding product use.

Trichlorfon, an organophosphate insecticide, is available by itself (Combot) or included in some combination dewormers to provide bot control. No other organophosphate or cholinesterase inhibiting products, such as those containing dichlorvos (Vapona), coumaphos (Co-Ral), or tetrachlorvinphos (Rabon) should be applied to horses at the same time, or within several days of treatment. The product label will give specific restrictions. Ivermectrin, the active ingredient in products such as Eqvalan, Zimectrin, and Protectin 1, controls bots and other internal parasites but is not a cholinesterase inhibitor. No supplementary bot control material is needed when using products that have ivomectrin as the active ingredient.

Consult your veterinarian about an appropriate parasite control program.

UK Internet Sites for Pesticide Applicator Training and Integrated Pest Management

Pesticide Applicator Training- Maintained by the Entomology department, this site is a continuous source of training information. Dates and locations of approved initial and continuing education meetings for commercial applicators which have been approved by the Division of Pesticides are posted regularly. One listing contains meetings in the state or close by. A second list contains national meetings. This site also provides access to publications and training manuals.

http://www.uky.edu/Agriculture/PAT/welcome.htm

Integrated Pest Management- Maintained by the Entomology department, this page has information on the program in Kentucky along with on line scouting information and fact sheets.

http://www.uky.edu/Agriculture/IPM/ipm.htm

UK College of Agriculture- This site has links to all departments and programs in the College.
http://www.ca.uky.edu/

Excerpts from *Action Line* , a newsletter published biweekly by the American Crop Protection Association. Don Collins, Margaret Speich, editors: (202) 872-3863; don@acpa.org; margaret@acpa.org.

NRDC FILES FARM CHILDREN'S PETITION

At a news conference October 22, the Natural Resources Defense Council filed a petition with EPA asking the agency to designate farm children as a
"major identifiable subgroup" under the FQPA, "treating them as a population at special risk." Alleging that farm children are "surrounded by a virtual sea of pesticides," NRDC says that EPA should take them into account when determining pesticide tolerances. ACPA and the pesticide industry, which supports the fundamental goals of the FQPA, especially the additional protection for infants and children, are conducting extensive > new studies to determine how all children, not just farm children, may come into contact with pesticides residues on food, in the water and from the surrounding environment. The industry also points out that there have been close to 100 new pesticide safety limits that have been established under FQPA since its enactment in August 1996 and, by definition, they are deemed by the EPA to be safe for everyone, including infants and children.

EXTENSION TOXICOLOGIST REBUTS NEWSWEEK ARTICLE

Although interviewed extensively for Newsweek's June 1 article on "Pesticides and Kids' Risks," Allan Felsot, Washington State University, was surprised to find none of his statements quoted. Instead, Newsweek editors opted to cite the "wisdom" in EWG's report, "Same As It Ever Was," alleging increased pesticide use and residues on food crops. So, he listed his facts in an editorial in the September 14 Tacoma News Tribune, sent to ACPA by Heather Hansen, Washington Friends of Food & Forests.

Felsot contends that "EWG...and other advocacy groups have a recurrent theme: There is a health crisis in America today because of pesticides. EWG wants the public to accept that...pesticide use is rising, pesticide residues in food are increasing and drinking water is even more polluted than a few years ago." The extension specialist on environmental toxicology then wrote that (a) pesticide use has risen only as more acres are farmed; (b) 90 percent of pesticides used on corn and soybeans are herbicides with residues rarely found in foods, and 29 percent of insecticides are used on cotton, which is not eaten; (c) lumping all pesticide residues together to assess risk is absurd; and (d) the level of pesticide residues in our waterways is not increasing, but, rather, how our ability to detect more minute amounts increase detection numbers.

PESTICIDES AND CHILD SAFETY

(Modified from an EPA Fact Sheet)

Although pesticides can be beneficial to society, they can be dangerous if used carelessly or if they are not stored properly and out of the reach of children. According to data collected from the American Association of Poison Control Centers, in 1990 alone, an estimated 79,000 children were in involved in common household pesticide-related poisonings or exposures in the United States.

A recent survey by the U.S. EPA regarding pesticides used in and around the home revealed some rather significant findings:

Almost half -- 47% -- of all households WITH children under the age of five had at least one pesticide stored in an unlocked cabinet, less than 4 feet off the ground (i.e., within the reach of children).

Approximately 75% of households WITHOUT children under the age of five also stored pesticides in an unlocked cabinet, less than 4 feet off the ground (i.e., within the reach of children). This number is especially significant because 13% of all pesticide poisoning incidents occur in homes other than the child's home.

Bathrooms and kitchens were cited as the areas in the home most likely to have improperly stored pesticides. Examples of some common household pesticides found in bathrooms and kitchen include roach sprays, chlorine bleach, kitchen and bath disinfectants, rat poison, insect and wasp sprays, repellents and baits, and flea and tick shampoos and dips for pets. Other common household pesticides include swimming pool chemicals and weed killers.

Lee Townsend, Extension Entomologist

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