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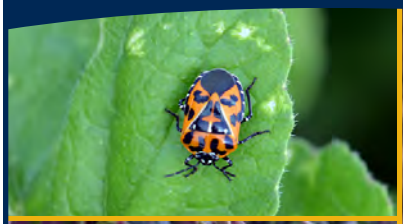

In This Issue:

New and improved techniques used to enhance crops

The previous issue of the *IPM Chronicle* discussed recent findings from the National Academy of Sciences related to the safety of genetically engineered crops on human health and the environment. Now, the discussion turns to the recent developments and the potential benefits of such modern techniques to produce genetically modified crops. In order to fully understand the advanced techniques developed to design crops, it's essential to understand past crop breeding methods.

History of Plant Breeding

Ever since humans domesticated plants to produce food about 10,000 years ago, they were continuously selected for desirable traits that occurred naturally. The field of classical plant breeding through cross-pollination witnessed rapid growth following the famous pea-plant experiments of Gregory Mendel who outlined the "rules of genetics" in the late 1800s.

As scientists began to understand that physical traits expressed was by virtue of genetic information, crude mutagens (agents that can alter the genetic sequence), such as radioactive rays or certain chemicals, were used to induce mutations to generate new varieties shortly after World War II. This was followed by plant tissue culture to induce and select desirable expressions. However, most of these methods were time consuming, cumbersome and often times dependent on trial and error.

Deeper Understanding

An understanding of DNA structure and function in the mid-1960s paired with the vast body of scientific literature that followed this fundamental discovery accelerated this discipline during the past five decades. As a result, scientists were able to genetically engineer crops and introduce the genes of foreign, and often unrelated, species to express certain desirable traits, such as herbicide tolerance (e.g., Roundup-Ready crops) and their ability to kill certain insect pests (e.g., *Bt* corn). They were referred to as transgenic crops since the technique involved the introduction of foreign genes into the genome of a crop species. Such transgenic crops have been widely adopted but have been under public and regulatory scrutiny. The regulatory processes became a hurdle in the rapid development of transgenic crops.

Current Practices

Recent advances in molecular biology have made it possible to edit the genes within a particular species as opposed to introducing those from another species. One of the major benefits of gene editing is that improved varieties can be developed and released without much regulatory interference since this practice is similar to older methods, such as classical breeding, mutagenesis or plant tissue culture, which were not regulated.

Several gene editing techniques are being developed by scientists. These techniques employ different agents collectively referred to "Sequence Specific Nucleases" to cut and customize gene sequences to achieve desirable end results. The four major classes of SSNs include clustered regularly-interspersed short palindromic

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Peach leaf curl management

Symptoms

Peach leaf curl, a disease caused by the fungus *Taphrina deformans*, first appears as reddish areas on developing leaves in the early spring. These reddish areas soon become thickened and puckered, causing the leaf to curl. The thickened areas turn pale yellow then grayish white, signaling spore production on the distorted leaf tissues.

Affected leaves turn brown or yellow and can either stay on the tree or fall off, causing decreased fruit production and tree growth. Due to this defoliation, fruits may become exposed, and therefore, prone to sunburn injury.

The fungus will also infect young, green twigs and shoots. In the case of severe and recurrent instances, shoots quickly become stunted, thickened, distorted or die, which severely reduces the vigor of the tree. The appearance of reddish, wrinkled or distorted areas on the fruit surface, though rare, can turn fruit corky and cracked.

Life Cycle

The spores overwinter in bark crevices and around the buds on tree twigs. The disease cycle starts when the overwintering yeast cells wash onto the swelled buds and emerging leaves in the early spring. The saprophytic yeast phase of the fungus switches to the parasitic mycelial phase by producing a short hypha that penetrates the protective layer. The fungus continues to invade the host tissue between the outer cells until it reaches the parenchyma cells below.

Long periods of cool (50 F to 70 F), wet (>95% humidity) weather facilitate infection.

Figure 1. Reddish areas on developing leaves are a symptom of peach leaf curl. (Photo credit: MM Rahman)

If warm temperatures follow bud swell and leaf development is rapid, infections are rarely established.

Leaf symptoms begin to show about two weeks after leaves emerge from the buds. The fungus grows around leaf cells and stimulates them to divide and grow larger than usual, causing swelling and puckering. Distorted cells accumulate red plant pigments. Fungus cells break through the surface of the leaves and produce sexual fruiting bodies, which in turn produce sexual spores called ascospores. These ascospores give the leaf a powdery, grayish white appearance.

The yeast phase begins with budding ascospores discharged from curled leaves onto peach twigs and bud surfaces. The fungus survives on the tree's surface as ascospores and bud conidia during the hot, dry summer. When the weather turns wet and cooler in the fall, ascospores germinate once again to produce more bud conidia.

Management

Resistant variety:
The best option for backyard growers is to use resistant peach and nectarine cultivars. Peach cultivars with tolerance to leaf curl are 'Frost,' 'Avalon' and 'Mary Jane.' However, these cultivars can still be susceptible during the first few years after planting and should be treated with preventative products.

Cultural control:
If you are observing leaf curl, wait until the end of the season to manage the disease. Even though some people prune infected areas, this has not been proven to be effective. Pruning in the fall prior to fungicide application can reduce the number of spores overwintering on the tree and reduce the amount of fungicide needed.

If leaf curl is severe during a specific season, maintain tree vigor by thinning more fruit than normal, irrigating to reduce drought stress and applying extra nitrogen fertilizer.

Fungicides:
With high disease pressure and notably wet winters, an application of fungicide in the fall is appropriate when 90 percent of the leaves have fallen despite the early spring application.

Dormant fungicide application should always be timed with temperature and bud swelling. During this time, apply chlorothalonil, Ziram, liquid lime sulfur or copper.

During 2017, the Mid-Atlantic region experienced an unusually warm February that influenced bud swelling and infection earlier than normal. Growers who applied fungicide at that time were able to control the disease. This highlights the need for tracking developmental stages for disease management.

Mulch in fall to prevent annual weeds in spring

Weeds are often noticed when they bloom, but by then, they have competed with desirable plants and can be difficult to control since they are well established. Weeds such as henbit (*Lamium amplexicaule*), purple deadnettle (*Lamium purpureum*), chickweed (*Stellaria media*) and hairy bittercress (*Cardamine hirsuta*) germinate in fall and early spring. As the soil starts to warm up, they grow rapidly and produce conspicuous blooms.

It is prudent to execute control measures before such weeds germinate. Applying a suitable mulch is a common practice to reduce weed germination by blocking sunlight. Mulches also serve a physical barrier that affects seed germination, conserves soil moisture and reduces the incidence of soil-borne diseases.

Landscape Mulch

Mulches to control weeds in the landscape include landscape fabric, wood chips and shredded wood. Landscape fabric is effective in perennial plantings, especially if they are installed prior to establishing a flowerbed then covered by a desirable medium. Aged wood chips are better than fresh chips to reduce tie-up of soil nitrogen required for plant growth. If fresh chips are used, apply a layer of compost beneath the mulch.

Temporary Mulch

Temporary mulch materials may include black plastic, straw over newspaper and dry grass clippings. Avoid using pine needles since they may affect plant growth. Also, avoid certain colored wood mulches as they can injure certain plants. If using lawn clippings, make sure that the lawn was not treated with herbicides or fertilizer-based herbicides. No more than 4 to 6 inches of mulch is needed in landscape plantings. A 6-mil black plastic is more effective than thin plastic, and landscape pins may be used to secure it to the soil.

Figure 2. Mulching before germination of winter annuals, such as hairy bittercress (Cardamine hirsuta), in early fall prevents weed infestations during subsequent spring; remove germinated seedlings prior to applying mulch. (Photo credit: R. Chandran)

Applying mulch before weed seeds germinate is critical for successful weed control. If weed seedlings have already emerged, a light cultivation or hoeing may be necessary to kill emerged weeds prior to applying the mulch. Certain pre-emergent herbicides, such as Snapshot or Pennant Magnum, may be used for control in landscape plantings. If using herbicides, please refer to the label to ensure that they are safe for the ornamentals used and apply them at the labelled rates and timings to avoid plant injury.

New and improved techniques

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repeats associated with Cas-nuclease 9 (CRISPR/Cas9); meganucleases; transcription activator-like effector nucleases (TALENS); and zinc finger nucleases (ZFNs). CRISPR/Cas9 is used most widely by scientists because of its simplicity for DNA targeting and gene editing.

Gene editing is promising and is considered to be less invasive compared to transgenic crops. Recently, a mushroom variety that can resist browning was developed by Penn State using this technology. It has also been considered in the development of golden rice capable of synthesizing vitamin A that has the potential to treat blindness associated with children nutritionally deprived of the vitamin. Although possible through a transgenic hybrid, its development and cultivation were hindered.

While regulation of gene editing technology is less stringent, widespread adoption and public acceptance is yet to be documented. However, companies are rapidly using these new tools to generate crops that are drought-, fungal disease- and herbicide-resistant. They're also being modified to protect against other agricultural pests, such as insects and weeds.

Ticks

Ticks are a parasitic group of arthropods more closely related to spiders, mites and scorpions than to insects. There are two major groups of ticks: hard ticks (Ixodidae) and soft ticks (Argasidae). Hard ticks get their name from a hard plate of exoskeleton (scutum) present dorsally behind the head. In males, the scutum completely covers the back, while in females the scutum only partly covers the back.The hard ticks are more common and more important as a pest to humans and animals. They feed on blood from their animal hosts, and several species are notorious for also transmitting disease-causing pathogens.

Identification

Common tick species found in West Virginia include the American dog tick (*Dermacentor variabilis*), blacklegged or deer tick (*Ixodes scapularis*) and lone star tick (*Amblyomma americanum*).

The American dog tick is the most commonly encountered tick in West Virginia. Although it can be found feeding on dogs, it will readily feed on numerous other animal hosts. They are brown to reddish-brown with cream or grayish colored markings on the scutum.

The blacklegged, or deer, tick is commonly encountered in mixed forests and along woodland edges. The larval and nymphal stages can be found feeding on small rodents (the preferred host is the white-footed mouse), while deer are the primary hosts during the adult stage. These ticks are chocolate brown in color, with adult females having an orange to red back surrounding the scutum.

The lone star tick is commonly encountered in dense woodlands and around animal nesting areas. They are reddish-brown to tan in a single white spot on the scutum.

Figure 3. Lone star tick, blacklegged tick and American dog tick. (Photo credit: Daniel Frank)

Life History and Habits

The lifecycle of ticks consists of four stages; the egg, six-legged larva (often called seed ticks), eight-legged nymph and adult (also with eight legs). Ticks must feed at each stage to complete their one- to three-year life cycle.

Ticks do not jump or drop from trees onto their hosts. They wait in a position known as questing, which is resting upon vegetation with their front legs outstretched waiting to climb upon a host.

In order for a tick to take a blood meal without being detected, it injects small amounts of saliva with anesthetic properties at the site of attachment. If the tick is infected with a pathogen, it is transmitted to the host through the saliva.

Management

Personal Protection

The most effective method for protecting oneself is to regularly check for ticks. The probability of a tick transmitting a disease-causing pathogen increases the longer an infected tick is attached.

When entering a habitat with a high risk of tick exposure, hike along trails, staying in the center to avoid brushing against weeds and tall grass. Wear light-colored clothing to make ticks easier to spot. Using a DEET-based repellent on skin and permethrin-treated clothing can also provide good protection

If an attached tick is found, remove it using thin-tipped tweezers or forceps. Grasp the tick as close to skin as possible and pull the tick upward with steady even pressure to remove the tick with its mouthparts intact to reduce the risk of infection.

Landscape Management

Desiccation (drying out) is a major cause of natural tick mortality. Taking steps to make vegetation and leaf litter dry out faster can make the area less favorable for ticks.

There is a positive correlation between the abundance and distribution of the blacklegged tick and the size of white-tailed deer populations. Deer management options, such as fencing, repellents, guard animals and deer-resistant landscape plantings, can also be used to help reduce tick populations.

Chemical Controls

Insecticides, or acaracides when used for ticks, can help reduce tick populations around the home, especially when combined with landscape management practices that decrease tick habitat. Fast-acting, residual formulations of synthetic pyrethroids (e.g., bifenthrin, permethrin) can be applied along yard perimeters, and other areas where ticks may inhabit. Spray treatments are

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Why are my apples cracking?

Fruit cracking is often a physiological response to environmental conditions, such as irregular water supply. It's common in the second part of the growing season that starts in July while the fruit is still relatively small and can go up to harvest. Two other factors, boron deficiency and apple scab lesions, can lead to cracking as well. But, by far, the response to irregular water supply is the main reason for this phenomenon.

In order to understand how cracking happens, we have to consider that there is a set number of cells in an individual fruit. Those cells expand to accommodate and retain water absorbed through the skin and by the root system. With sudden influxes of water and low rates of evapotranspiration due to high humidity and low wind, the cell walls will rapidly expand and stretch until they reach the breaking point. That breaking point is not the same for all apple cultivars. Different cultivars have different epidermal and sub-epidermal thicknesses. Cultivars with thicker layers are more resistant to cracking.

Figure 4. Cracks due to severe scab lesions. (Photo credit: M. Danilovich)

There are several other contributing factors to cracking:

- *Poor tree vigor* – stressed trees that are suffering from malnutrition will not produce abundant foliage and strong flower buds. The fruit set on stressed trees is low, coupled with excessive fruit drop. Those trees will have poor growth resulting in reduced canopy size or a smaller surface for evapotranspiration that leads to increased fruit cracking.
- *Very late and hard pruning* – can affect normal growth of foliage leading to overall reduction of surface area for evapotranspiration that results in fruit cracking.
- *Poor fruit set and/or over-thinning* – few fruits left to absorb all the sudden, excess water can result in fruit cracking.
- *Apple scab infected areas* – are not capable of cell division and expansion that results in cracked fruit.

Susceptible Cultivars

The most susceptible cultivars to cracking are Stayman, York Imperial, Wealthy, Fuji, Gala and Golden Delicious, mainly late in the season. For Stayman and Wealthy, the cracks are found on the green cheeks as irregular lines that could be barely visible or extend deep into the flesh and circle the entire fruit. The York exhibits numerous horizontal cracks, mainly concentrated around the fruit's equator nearing ¼ inch deep. When fruit is close to maturity, Gala and Golden Delicious cultivars develop cracks around the stem in the stem cavity. The shallow cracks often heal and the fruit develops scars that resemble cork and deform the fruit. Deep cracks, especially ones on fruit near maturity, are attractive to many insects and susceptible to secondary pathogens that can lead to decay.

Figure 5. Cracking due to excess water. These splits/open wounds are entry points for pathogens that will decay the fruit. (Photo credit: M. Danilovich)

Prevention

What could be done to prevent this? There is not much we can do about the weather, but cultivar choice and tree care is in our hands. Avoid the crack-prone cultivars mentioned above. Tree maintenance, such as pruning, fertilization, fruit thinning, and insect and disease protection, should be provided on a regular, timely basis in order to minimize fruit cracking.

Ticks

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most effective when applied using a high-pressure sprayer in the spring when nymphs become active. An additional application in the fall can be used to target adult ticks.

Another option is to target acaracides on small mammals that may be living in the area. In many instances, mice are the reservoir hosts responsible for producing disease-carrying ticks.

Vole control

Homeowners are sometimes confused regarding what is causing damage to their lawns and flowerbeds. Many will blame moles for damage in their yards when a separate species, the vole, is the culprit. Moles are fossorial (found digging and living underground), and landowners most often see evidence of moles in the raised ridges, surface tunnels or mounds they create. Voles are semi-fossorial (partly or sometimes found digging and living underground) and are most often noticed by runways through grass, thatch, mulch or leaf litter above the soil layer instead of by the raised tunnels produced by the burrowing moles.

Vole Habits

Voles are rodents that feed on vegetation, fungi, fruits, nuts and seeds. Their runways are found in the deep thatch, mulch, loose dirt and leaf litter. They often leave grass clippings behind in these runways. Voles will enter short underground burrows to nest; however, their runways are mostly above the surface of the soil. The most identifiable sign of voles is their extensive surface runway system through flowerbeds or lawns. Voles are active both day and night year-round. They do not hibernate and continue to feed and produce tunnels beneath snow.

Vole Damage

Landowners most often notice vole damage by finding girdled plants or shrubs and trees that are gnawed on right at, or slightly above, ground level. Voles will climb up into vegetation and bite off branches, or feed on fruits and vegetables.

White-tailed deer are often blamed for vole damage. Deer do not have upper incisors and will leave a small tendril of vegetation when they bite and tear the plant. Voles have pronounced upper and lower incisors resulting in a clean cut. Voles will eat small portions of fruits and vegetables, leaving them on the vine or stem. Deer, however, normally break fruits and vegetables off the stem or vine.

Figure 6. Vole runways are found in the deep thatch, mulch, loose dirt and leaf litter. (Photo credit: https://www.flickr.com/photos/ troutcolor/ 5565004949)

Vole Control

Habitat modification practices, such as removing thatch, leaf litter or mulch, in areas that support voles can reduce the likelihood of vole damage. Regularly mowing lawns or turf to reduce grass height and cover can also help reduce vole damage, as can clearing mulch from flowerbeds or around the base of trees to a 3-foot radius. Hardware cloth can be used to exclude voles from seedlings, trees and shrubs. The mesh size should not be any larger than ¼ inch and it may need to be buried about 6 inches to prevent voles from burrowing under.

Trapping can be effective in areas of small vole populations. Place mouse snap traps perpendicular to runways with the trap pan in the runway. Pieces of apple or peanut butter and oatmeal can be used as bait for voles, but a non-baited trap will also work.

Toxicants to control voles are available at your local home and garden stores. Use these with extreme caution, as non-target animals, such as pets and beneficial animals, may pick up the toxic bait or eat the contaminated carcasses of deceased voles.

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