UNIVERSITY OF MARYLAND EXTENSION
AgFS
Agriculture & Food Systems

Fruit & Vegetable News

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Inside this Issue:

usual Disease of Garlic Scapes Found n Maryland

By Jerry Brust, UME and Karen Rane, UMD Plant Diagnostic Lab

A grower noticed over the last few years lesions developing on their garlic scapes which then collapsed in the field. In previous years these collapsed scapes amounted to only a small number, but this year the losses are much greater approaching 30%. Symptoms consist of sunken lesions about ¼ to ½ inch long, that cause twisting, girdling and collapse of the scape. Lesions initially are cream to tan-colored but under rainy or very humid conditions, spore production by the fungus causes lesions to turn orange (fig 1). This disease is anthracnose of garlic, a new disease to Maryland and is caused by the fungus *Colletotrichum fioriniae*. The fungus may survive on crop residue in the soil from a previous garlic crop or the disease may be spread by infected bulbils used for propagation. Disease development is favored by rainy or very humid weather and warm temperatures (78-88° F). Anthracnose of garlic does not affect bulbs, but scape yield could be reduced as will bulbil production.

Reports from New England indicate that onion is most likely not affected by this fungus. *C. fioriniae* has also been reported as causing bitter rot on pear and anthracnose on celery and cherry tomato. Crop rotation away from any member of the onion family may help reduce disease incidence. Besides crops, weeds such as common lambsquarters, redroot pigweed, yellow nutsedge and common groundsel may also be infected with the pathogen but be symptomless. Because this is such a new disease of garlic, fungicide recommendations have yet to be determined. However, products that are labeled and effective against purple blight of onion may be useful against this disease.

Fig. 1 Collapsed base of scape with white lesion and orange spores (left) and twisted orange scape stem (right). Images by M. McLearen)

Blossom End Rot Common so Far this Season.

By Jerry Brust, UME

This summer has been unusual as it has been about normal for temperatures if not a little cooler, but we have had greatly varying amounts of rainfall over the last month. Some areas have remained dry with storms just missing farms while others have been hit with some heavy rains. This can make watering vegetables challenging to avoid problems such as blossom end rot, which is caused by a calcium deficit in the developing fruit.

Fig 1. Several different vegetables with blossom end rot.

Calcium (Ca) moves to the plant via mass flow, i.e., where dissolved minerals like calcium move to the root in soil water that is flowing towards the roots. As it passes through the plant Ca is deposited in tiny amounts into the fruit. If anything slows or interrupts this stream the tiny amount of Ca needed at that moment is not deposited and the area furthest from the top of the fruit suffers—resulting in blossom end rot (BER). I have seen more BER this year on a large number of different vegetables than I have in the past several years (fig 1).

Figure two shows how precise and constant the Ca flow in a plant has to be to supply just the right amount of Ca at the right time. The large fruit on this particular plant developed before there was a Ca interruption, but the fruit a little younger suffered a Ca interruption, with the smallest (youngest) fruit suffering the greatest Ca interruption. At the time it was taken tissue analysis from this same plant showed that calcium was in the moderate range when the blossom end rot took place, demonstrating the importance of irrigation and water supply to reduce blossom end rot. Not much you can do about no rains or heavy rains, except try to maintain as even a water supply to your vegetables as is possible and remove any fruit from the plant you find that has blossom end rot.

Fig. 2 Older larger fruit received enough Ca, but younger (smaller) fruit did not

COVER CROP SIGN-UP IS NOW OPEN

Soil conservation districts are now accepting grant applications from farmers who want to plant cover crops this fall to protect local water quality and build their soil's health. Reimbursement rates range from $55/acre to $95/acre, depending on the selected planting method and incentive options. New this year, our Cover Crop *Plus*+ grants offer higher incentive payments for farmers who sign a 3-year cover crop commitment to improve soil health. **The deadline to apply is July 18,2022**.

Call your local Soil conservation districts for more information.

Maximizing Apple and Peach Profits with Preventative Bruising Practices

By Morgan Jacobs, Candidate for B.S. in Physiology and Neurobiology
and Dr. Macarena Farcuh, Assistant Professor and Extension Specialist
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Although harvest is one of the most frantic times of the season, peak harvest time needs to be balanced with preventative practices to help ensure that the crop has optimal quality for satisfying consumer demands, and to ensure profitability of the operation. The degree of fruit quality can be highly determined by the preharvest, at harvest and postharvest practices in an orchard. Profits can be maximized by producing appealing fruit, by minimizing fruit damage and loss.

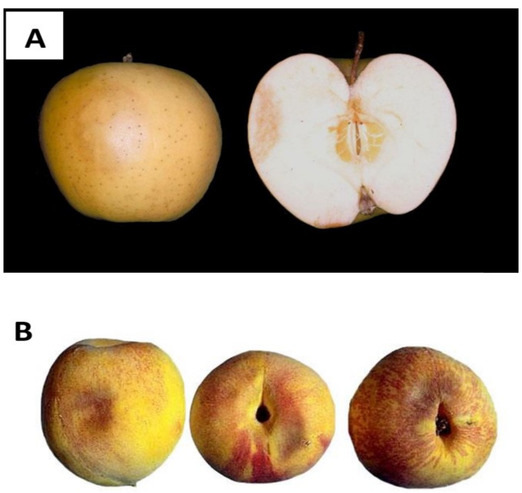

Fig. 1. (A) An apple and (B) peach fruits affected by bruising, indicated by the darker discoloration patches on the surface. Source: Don Edwards, UC Davis

One crucial factor, affecting both internal and external quality of fruit that needs critical attention is bruising. Bruising occurs when the fruit has been compressed and/or impacted by forces in a concentrated area of the fruit, causing an external and internal injury affecting the quality of product (Fig. 1A, B). Undoubtedly, bruising is a common defect that is faced when growing fruit, but there are multiple management principles to put in place to decrease the amount of these damage. This article covers practices and procedures that should be adopted throughout critical points from harvest to storage, so that the probability of bruising can be reduced to the minimum and thus effectively increase profits and fruit marketability.

Properly Harvesting Peaches and Apples from the Tree to the Bin

A key source of bruising occurs from apples absorbing high loads of energy. By providing pickers with proper tools for harvesting, the magnitude of energy possible for the apples to absorb one would greatly decrease. Workers should be provided with a hard bucket with a soft, padded interior (Fig. 2). If the bucket is dropped, the hard exterior absorbs outside energy, while the interior protects the apples from the hard exterior. To properly wear the bucket, securely strap over the picker, mid chest height. The hands-free style provides stability to the picker, while they mount and dismount the ladder. These buckets can generally hold ½ to 1 bushel of apples. Another practice to incorporate is the use of three-legged alumi-

Fig. 2. Apple harvester wearing a hard bucket with a soft, padded interior located right below mid-chest level. Source: Emily Elconin, Getty Images.

num ladders. Researchers found that putting two -legged ladders against the tree damages it and results in a greater amount of unnecessary bruised fruits.

While picking apples, field hands should perform the following preventative picking techniques to reduce bruising:

- Handling the fruit like an egg
- Securing the harvesting bucket
- Checking the quality and stability of the ladder
- Holding fruit in the palm of the hand and roll upward until stem snaps from tree. Never “pluck” the fruit from the tree by pulling it off (Fig. 3)
- Slowly placing their hand inside bucket followed by releasing the fruit

Fig. 3. Apple harvested incorrectly as the fruit was “plucked” from the tree by pulling it off. Source: M. Farcuh, University of Maryland.

Unlike apples, peaches are less sturdy, and harvesters need to adjust harvesting and handling practices. When harvesting consider the following techniques to reduce bruising:

- Squeeze *gently* if necessary to gauge firmness
- Large peaches located at the top of the tree, ripe first
- A ripe peach will easily depart from the tree. If effort is needed to pluck, leave the peach on the branch
- Use the sides of the fingers instead of fingertips
- Pull peach straight off the branch
- Place gently into the basket

Most of these practices depend on the pickers motivation to uphold procedures. To ensure that preventative measures are upheld, it is suggested to have an active supervisor in the field to watch over and award incentives and/or penalties towards appropriate harvesters. One method a supervisor can implement is that each field worker picks a box of apples, then labels the box with their name. Place the box of apples in the cooler. Then the next day have the field worker sort and analyze the apples to identify where bruises developed and see if there is a correlation between bruising and finger placement. This activity will show the field hands how their picking affects the quality of harvest.

Hauling the Bins of Peaches and Apples Safely Out of the Orchard

After harvesting the fruit, the bins will be transported to the outside of the orchard via tractor. The type of tractor and wheel quality depends on the growing area to minimize the amount of energy transferred from tires to the apples in the bins, while balancing with terrain. In addition to the prevention of bruising, by choosing the appropriate tire to tractor ratio, the overall yield of the crop can be increased (Fig. 4). It has been reported that without proper distribution of weight, the compaction of topsoil and subsoil from tires can decrease production yield up to 10%.

Fig. 4. A tractor pulling the trailer full of apple bins has proper tires needed to transport the apples across the soil. Source: University of Maine, Cooperative Extension.

Moving the Bins to the Exterior Loading Docks of the Orchard

If the edge of the orchard is close to the destination from the previous section, the transfer can be combined in one step to minimize contact of the fruit. If distance is too large and damage would be predicted by using the tractor, then the recommendation is to use a multi-bin trailer. To reduce contact with fruit and to effectively transport fruit from tractor to the trailer, instead of hauling bins individually, use a multi-bin conveyance system to safely transport large amounts of fruit. If individually carrying the bins is the only option, ensure that the load is not too heavy, and vision is not impaired to prevent tripping and dropping of the crop. Other precautions to implement is ensuring the loading area is as smooth as possible. Potholes or large defects in the road increase potential energy the apples can absorb.

Loading the Bins with Fruit to the Truck

When transporting the fruit from the loading dock to inside the truck, be sure to keep in mind maximum load weights and an obstacle free area while carrying bins. Bulk bins can be used in storage. The problem with using bulk bins is the limitation of weight restrictions; however, they allow the easy and safe movement of fruit through a forklift. If possible, use rubber-tired forklifts to transport a copious amount of fruit.

Transporting the Fruit Bins to storage via Truck

The most significant concern when transporting fruit in a truck is the quality of roads. Rough roads produce large bumps, then energy transfers to the fruit inside inflicting damage to the fruits, which will subsequently getting bruised. By properly training truck drivers to avoid roads with destructive defects, one can reduce the potential damages to fruit. In addition to choosing the smoothest roads, drivers should be trained to drive the speed limit and how to use air cushioned brake suspicion system, effectively decreasing the amount of road shock available to the fruits. Pallets and/or bins used in the truck must be of good physical condition as poor condition pallets could topple over during transport.

Hauling Bins to storage via Forklift

The area used during this transportation stage should be paved smoothly. The forklifts should be equipped with shock-absorbing suspension to again, reduce the amount of energy transferred to the fruits. If the transporting area is not smooth, shock-absorbing suspension is especially important as well as trained drivers to take precautionary actions to avoid rough areas.

Apple Grower Workshop!

Harvest and Postharvest Practice for Improving Apple Fruit Marketability: Fruit Quality and Safety.

- **Monday November 7, 2022, 8:30 am—4:00pm**
- **At the Western Maryland Research and Education Center, Keedysville, MD.**
- **Admission $20**

For more information or accommodations contract Dr. Macarena Farcuh, mfarcuh@umd.edu

Corn Disease Identification

By Alyssa Koehler, Extension Field Crops Pathologist; akoehler@udel.edu

Note this article was first published July 8 on University of Delaware Weekly Crop Update.

As corn is beginning to tassel, it is a good time to scout fields to decide if a fungicide will be applied. While you are out scouting, here are some tips for sorting out pathogens.

Fig 1. Rectangular lesions of Grey Leaf Spot on Corn

Grey leaf spot (GLS) is our most common foliar disease of corn. Symptoms usually begin on lower leaves as small, tan, rectangular lesions with a yellow halo. When lesions are young, they can be difficult to distinguish from other common corn foliar diseases. As lesions mature, they become more diagnostic. At maturity, lesions are grey to tan in color, with a long rectangular shape (Figure 1); partially resistant hybrids can have more jagged margins than lesions on susceptible cultivars. Lesions often join to form large necrotic areas under favorable environmental conditions. Yield reductions are typically observed when lesions are present on the two leaves below the ear leaf or higher, so these are the leaves to pay close attention to when scouting. If over 50% of plants have lesions on 5% or more of this leaf surface (flag leaf or 2 below), you may want to consider a fungicide application. If applying a fungicide, VT/R1 timing has shown the greatest chance of economic return for GLS. The 2022 Fungicide Efficacy for Control of Corn Diseases, provides ratings of product performance across multiple diseases based on trials conducted by Extension specialists across the country.

Curvularia leaf spot is a new disease that was first observed in the region at the end of 2020. Lesions will have a brown border with a yellow halo that can look very similar to the start of a GLS lesion. However, these lesions will usually stay small and round, while GLS lesions will continue to expand to a rectangular shape (Figure 2). Lesions can be scattered or in dense groups. At present, this disease is not associated with notable yield loss and foliar fungicides are not labeled for management of Curvularia leaf spot.

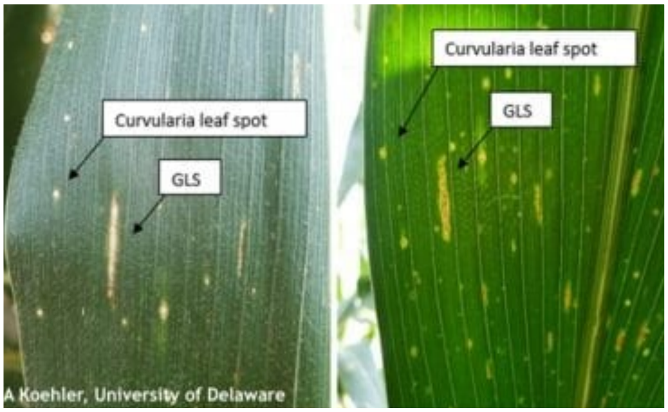

Fig 2. Curvularia leaf spot v. GLS on the upper (left) and lower (right) corn leaf.

Northern Corn Leaf Blight (NCLB) is present in the regions at low levels, often showing up later in the season. Like many of the foliar pathogens, it is favored by prolonged wet weather and canopy moisture. These lesions will be oblong to cigar shape (Figure 3).

Fig 3. Northern Corn Leaf Blight lesions

Diplodia leaf streak can be observed occasionally in the region, most often in fields with corn on corn rotation. These lesions can look similar to NCLB, but inside of the lesions you will see black dots called pycnidia that contain spores of this fungus (Figure 4).

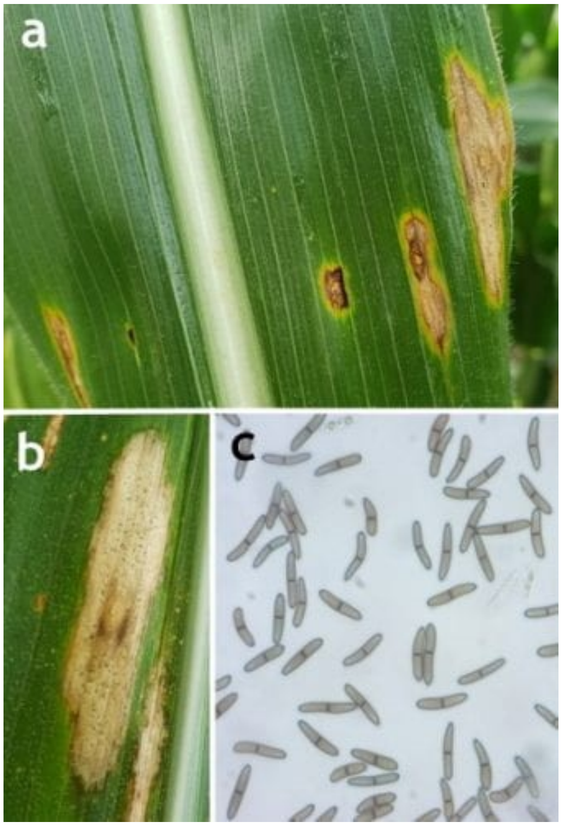

Fig 4. Symptoms of Diplodia leaf streak (a), close up of a lesion with black pycnidia (b), pill-shaped spores of Stenocarpella maydis (c)

As you are out scouting this year, you will also want to keep an eye out for **Tar Spot**, a foliar disease caused by the fungus *Phyllachora maydis.* It first showed up in northern Illinois and Indiana in 2015 and was found in Lancaster County at the end of the 2020 season and continued to spread to surrounding PA counties in 2021. To date, this disease has not been reported in DE or MD. The fungus produces small, raised, black bumpy lesions that look like specks of tar, giving it the common name of tar spot (Figure 5). These structures known as stroma can be on the upper or lower leaf surface and do not wipe off the corn leaf. In severe cases, lesions may also be observed on the leaf sheaths, husks, and tassels. Tar spot is most often observed after silking, but can appear earlier, particularly in areas where it is established. If you suspect you have Tar Spot, please contact your county Extension agent or submit a sample to your local plant diagnostic lab for confirmation.

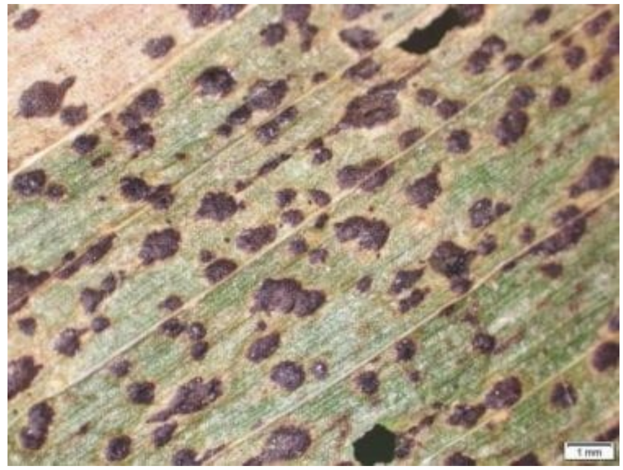

Fig 5. Slightly raised, black stroma of Phyllachora maydis. Source: cropprotectionnetwork.org/

Tomato Spotted Wilt Virus in Tomatoes

By Jerry Brust, UME

A few high tunnels and even a couple of tomato fields have been found with tomato spotted wilt virus (TSWV) in Maryland. The high tunnel finds were not too surprising but the fields were, as we usually do not see field infections until much later into the season. TSWV has also been found in greenhouse and field production of cut flowers. So it appears this virus is more common this year than it usually is, most probably due to greater thrips populations being present in our greenhouse production areas.

Tomato spotted wilt virus (TSWV) is an obligate parasite, i.e., it must have a living host and must be moved from one plant to another by thrips or through cuttings or possibly seed. This disease can affect tomato and other Solanaceae crops as well as lettuce, beans and cucumber. TSWV may occur in the field but tends to affect greenhouse and high tunnel crops more severely. TSWV is transmitted most efficiently by Western flower thrips (WFT) (*Frankliniella occidentalis)*, and less so by Onion thrips (*Thrips tabaci*), Tobacco thrips (*Frankliniella fusca*) and several other thrips species. It is not transmitted by Eastern flower thrips (*Frankliniella tritici*).

Western flower thrips completes its life cycle in about 10-18 days. Eggs are laid in the leaf or to-

Fig. 1 Tomato leaves with TSWV symptoms. Photo: K. Rane, Univ. Maryland

mato fruit. When WFT oviposit into tomato fruit they often cause a deeper dimple than other thrips species and very often the dimple is surrounded by a white halo of tomato tissue. Larvae hatch in about three days and immediately begin to feed and in so doing pick up the virus. After four days, they pupate in the soil, and in a little over three days, the pupae become adults. Only immature thrips can acquire the virus, which they can acquire within 15 minutes of feeding, but adults are just about the only stage able to transmit the virus. Adults can transmit the virus for weeks. It may take 2 - 4 weeks from when the adult thrips first feeds on a plant until initial symptoms are observed. Because of this TSWV appears to worsen in plantings over time.

TSWV infected leaves can show small, dark-brown spots or streaks (fig. 1) on stems and leaf petioles. Growing tips are usually affected with systemic necrosis and potentially stunted growth. Tomato fruit will have mottled, light green or yellow spots or rings usually with raised centers (fig 2).

Fig. 2 Tomato fruit with TSWV symptoms. Photo by G. Brust, Univ. Maryland

The host range for TSWV is one of the largest of any plant virus – hundreds of plant species, including vegetables, ornamentals and weed species, are susceptible. Weed hosts act as important virus reservoirs for TSWV and can survive in and around greenhouses, high tunnels or fields. Some of these weeds include prickly lettuce, chickweed, spiny amaranth, lambsquarters, black nightshade, shepherd's purse, galinsoga and burdock. These weeds as well as adult thrips need to be controlled in the greenhouse where vegetable transplants are being produced. Because thrips are commonly found in bedding plants or other flower production areas vegetable transplants should never be grown in the same GH as these ornamentals.

Tomato Pith Necrosis in Maryland

By Jerry Brust, UME

Fig. 1. Beginning of pith necrosis- leaves anywhere on plant can turn yellow. Photo by G. Brust, UMD

In the last week a few tomato fields in Maryland were found with the same disease called tomato pith necrosis. Just about all the problem tomatoes were from early planted fields. Tomato pith necrosis is caused by the soil-borne bacterium *Pseudomonas corrugata.* Although in the past this disease occurred sporadically in Maryland, over the last few years it is appearing more frequently. Tomato pith necrosis usually is found in early planted tomatoes when night temperatures are cool, but the humidity is high, and often plants are growing too rapidly because of excessive nitrogen application. We have had a spring/early summer with some cool nights and high humidity.

In the field, diseased plants occur randomly with initial symptoms often being seen as the first fruit clusters reach the mature green stage. Symptoms include chlorosis (yellowing) of lower, middle and even younger leaves (fig. 1) followed by wilting of the infected shoots in the upper part of the plant canopy. This wilting is usually associated with internal necrosis at the base of the stem and black streaking may be apparent on the surface of the main stem, which often splits (fig. 2). When the stem is cut open along its length or cross-wise (fig. 3) the pith will be discolored and may have hollow areas. There is often prolific growth of adventitious roots in the stems that have a discolored pith (fig. 4) and the stems can appear swollen.

Fig. 2 Tomato stem with dark streak and lesions on its surface. Photo by G. Brust, UMD.

There is little that can be done for control of pith necrosis. The best practice is prevention by avoiding the use of excessive amounts of nitrogen in tomato, especially early in the season when nights are still cool. There is some evidence that the pathogen may be seedborne, but more research is needed on the epidemiology and management of this disease.

Fig. 3 Darkened pith of tomato stem. Photo by G. Brust, UMD.

Fig. 4 Prolific growth of adventitious roots on

July Vegetable IPM Tips

By Emily Zobel, UME, Dorchester County

Check > 50 plants throughout the whole field when making treatment decisions. Localized infestations can be spot treated to save time and money. For up-to-date chemical recommendations, check the Mid-Atlantic Commercial Vegetable Production Guide. Read all labels carefully for rates and restrictions.

Cucurbits: Continue to scout for aphids, and spider mites. Early detection is critical since these pest populations can quickly explode during hot, dry weather. The first generation of striped cucumber beetles are active. Check for rind feeding pests such as beet armyworm, yellow-striped armyworm, cabbage loppers, and cucumber beetle adults in melon fields.

Sweet Corn: Sample pre-tassel stage for whorl feeders (corn borer, corn earworm, and fall armyworm). Treatment should be applied when 15% of plants are infested with larvae and should be directed into the whorls.

Lima Beans and Snap Beans: Scout fields for aphids, leafhoppers, and spider mites. The leafhopper threshold is an average of 5 per sweep. As soon as pin pods are present, check for plant bugs and stink bug adults and nymphs. As a general guideline, treatment should be considered if you find 15 adults and/or nymphs leafhopper per 50 sweeps. Continue to scout for bean leaf beetles and Mexican bean beetles—Control when there is an average of 20% defoliation or 1 beetle per plant.

Potatoes: Scout fields for Colorado potato beetle, leafhoppers, and aphids. Controls will be needed for green peach aphids if you find 2 aphids per leaf during bloom and 4 aphids per leaf post-bloom. This threshold increases to 10 per leaf at 2 weeks from vine death/kill. If melon aphids are found, the threshold should be reduced by half.

Vegetable Production and IPM Twilight Walking Tour

Evening of Friday- July 29th, 2022
Rain or Shine

Registration Not Required

Refreshments and Homemade Ice Cream at 5:30 p.m. with the tour from 6 p.m. - 8 p.m.

To be held at the farm of:

Stauffer Produce

Mahlon Stauffer Jr.

28455 Point Lookout Rd

Leonardtown, Maryland

For more information or accommodations *call Ben Beale at 301-475-4481 or email bbeale@umd.edu*

UNIVERSITY OF MARYLAND EXTENSION

Mowing: A Casually Thought of Integrated Weed Management Tool

By Dr. Cerruti R Hooks, Professor and Extension Specialist Entomology, and Dwayne Joseph, UME.

Mowing is a relatively inexpensive mechanical weed management option that imposes minimal disturbances to the soil. Several types of commercial mowers including rotary, flail, reciprocating sicklebar and reel can be used to suppress weed growth. Still, mowing is generally not thought of as a formable integrated weed management (IWM) tool as it is not congenial to most cropping systems or all land types. For instance, having a smooth soil surface free of rocks or other obstructions is a necessity for mowing operations, and if mowing close to the ground, the soil surface should be even. Some have declared that mowing is primarily used to limit seed production and restrict unsightly weed growth in untilled herbaceous and woody perennial crops. It is important for managing vegetation in pastures, meadows, rangelands, grassed waterways, field margins, turf, orchards, tree plantations, vineyards, golf greens and lawns as well as conservation reserve land and roadsides (Fig. 1). In In conservation ecology, mowing may be used to shift plant succession and encourage native plant establishment while discouraging undesirable vegetation. In some non-cropping environments, the mower is used primarily for aesthetic reasons. Still, preventing weeds from reaching maturity beyond crop fields is of critical importance as it can prevent these areas from serving as nurseries for weed proliferation. For example, several species of arable weeds are frequently present in field boundaries such as road verges and some can colonize and reproduce in crop fields. Mowing can be deployed to prevent these and other weeds from producing seeds. However, mowing is ineffectual in destroying vegetative (asexual) structures such as rhizomes (below ground stems), stolons (aboveground stems) corms, tubers and bulbs in which very small structures may result in a new plant. This suggests that mowing may not be compatible with all weed types. Still, it can contribute to an IWM program especially if used in concert with other management tactics.

Fig. 1. Transportation maintenance specialist mowing an interstate roadside. Photo: Oregon Department of Transportation (CC).

Mowing Effects on Weeds

Mowing defoliates plants and because leaves collect carbon dioxide and sunlight, defoliation alters their competitive ability. Mowing can reduce weed vigor, growth, survival and reduce or prevent seed production. Mowing kills existing shoot growth. However, mowed plants can produce additional shoot material and there is also potential of new stem development from previously dormant lateral buds. Still, this may be desirable as new stems grow at the expense of below-ground stored food. As such, repeated cutting hastens food depletion and death of some plants. Under frequent mowing, a plant must generate enough photosynthates under limited leaf area to fuel normal plant function while not depleting carbohydrates stored within the roots. Mowing can also delay flowering of some weed species and impact weeds indirectly by changing their environment. For example, light, temperature and soil moisture among other abiotic factors may change in a mowed plant community. This can occur because mowing creates vegetative gaps by removing plant parts that form a canopy and shades the soil surface. As a result, light intensity and quality changes at the soil surface. Further, the average daily soil temperature and diurnal temperature range at the soil surface increases. These abiotic changes on the ground can favor the germination or emergence of one or more weed species that would have otherwise remained dormant or suppressed. Plant residue that remains after mowing may also change abiotic conditions at the soil surface and subsequently influence the weed community. Mowing also changes the competitive relationships between neighboring weeds and other plants because different plants are impacted varyingly by mowing, some may die or regrow at different rates. As such, mowing can change the flora in an area. Thus, understanding how mowing impacts the biology of different weeds is important as it can be used to manipulate a plant community so that it favors native or other desirable plants.

Fig. 2. Plumless thistle, Carduus acanthoides Photo: Andreas Rockstein (CC)

When to Mow

Properly timed mowing can suppress unwanted vegetation while favoring desired plant flora. Integrated weed management should target the susceptible stages in a weed's life cycle and if mowing is being conducted to prevent seed production, it should always be done prior to flower formation. Mowing weeds during this stage can weaken them as they have invested a lot of energy into producing reproductive structures. Mowing to limit weed seed production is usually initiated well after mowing designated to minimized weed-crop competition and yield reductions. Oftentimes, a single mowing will not prevent seed production. New stems below the initial cut can flower and produce seeds. Thus, two or more mowing may be required to inhibit seed formation. However, some weeds such as common ragweed are able to survive repeated mowing. As a general rule of thumb, if only one mowing per growing season is allowed, it should be timed to match weed flowering. Certainly, mowing can be challenging when several weeds with different flowering phenologies co-infest the same site. For instance, mowing timed to prevent viable seed production of one weed species may fortuitously be timed to spread viable seeds of other species. This suggests that tradeoffs may persist when multiple weed species are present in a habitat and mowing is the option. Further, developing seed heads should be mowed before viable seeds are formed. Thus, timing is critical and should precede anthesis, pollination and fertilization. Some viable seeds can form less than 7 days after anthesis. For example, mowing musk thistle within 2 days after anthesis prevented viable seed production. However, mowing was ineffectual if it was conducted 4 or more days following anthesis. The production of viable seeds can occur so instantaneously that if weeds are not mowed before flowering, the benefits may only be cosmetic, especially if the delay results in more weed seeds being deposited into the soil seed bank. Still, variation exists among weed species relative to the best phenological stage to mow. For example, a six-year study in MD found that mowing plumeless thistle (*Carduus acanthoides;* Fig. 2) at the full bloom stage reduced plant densities compared to mowing it at the full bud or post bloom stage. In the same study, musk thistle (*Carduus nutans*; Fig. 3) declined only when mowed after the bloom stage. Some weeds have the ability to compensate for mowing effects. They may deploy several strategies to survive mowing such as increasing their photo-

Fig. 3. Musk thistle, Carduus nutans. Photo: Gertjan van Noord

synthetic rate and tillering, and obtaining greater nutrients.

Properly timed mowing helps minimize weed reinfestation, population increase and seed dispersal of new weed species within fields or from field borders into neighboring crop fields. If mowing is poorly timed, it can spread viable weed seed including herbicide-resistant weeds beyond the current field of infestation. Weed seed dispersal by mowing has been reported to be greatest when mowing and seed set coincide. A study showed that early mowing of chervil (*Chaerophylum aureum* L.), a weed that infests pasture, reduced seed production by decreasing shoot density and seed set. However, mowing it later resulted in seeds spreading outside the study site. Relative to this, some studies have shown that mowing practices can enhance seed dispersal of some weed species especially those that are favored by disturbances. Mowing may spread weed seeds by blowing them from the mowed area or transporting them on different mower parts. Thus, cleaning mowers between sites may help prevent weed spread. The regularity of mowing weeds is partially contingent on their tolerance to mowing which is a function of their growth rate, foliage replacement ability and its potential to increase photosynthesis to compensate for leaf loss following mowing. Further, multiple mowing will be required to mitigate seed production if weeds being targeted set seed or emerge in flushes over an extended time period. However, for weeds such as common ragweed, time of mowing and stage of growth may be more important than mowing frequency. Common ragweed can tenaciously regrow after most of its above ground tissues has been removed (Fig. 4). A study demonstrated that despite a substantial loss in aboveground plant tissue, surviving ragweed plants were able to reach the flowering stage after four clippings during the growing season. Similarly, spotted knotweed (*Centaurea stoebe*) produced tillers and flowers following 3 clippings in a single summer.

Mowing height is also critical as the blades must be low enough to cut off developing seed heads. However, if plants are initially mowed too low, later forming seeds may develop so close to the ground that a second mowing misses them. In addition, conditions may favor the regrowth of mowed weeds. Some annuals such as horseweed will sprout new stems below the cut. This growth may be managed by cutting high at the initial mowing and markedly lower at the next mowing so as to cut off any stems that have sprouted. This strategy is most effective if by the second mowing, the stem is hard and woody, and incapable of developing new sprouts beneath the cut.

Fig. 4. Common ragweed (Ambrosia artemisiifolia). Photo: F. D. Richards (CC)

Mowing and Perennial Weeds

Perennial weed control can be costly as well as time consuming. Perennial weeds are typically managed with herbicides and/or aggressive tillage. However, being dependent on herbicides to suppress perennial weeds encourages the development and spread of herbicide-resistant weeds; and an intensive tillage program increases the risk of soil erosion and on-farm energy use. A primary reason that perennial weeds are so resilient is their ability to store reserves in their underground storage organs. This allows above ground regrowth to occur after disturbances. Additionally, the resources in these storage organs are passed on year after year. As such, control measures should target and destroy the underground storage network or disrupt them by reducing or eliminating their ability to translocate resources formed during photosynthesis to other plant parts. Tillage can be used to weaken and destroy the underground storage organ. If it weakens it, the plant becomes more susceptible to other management tactics such as growing a competitive crop and mowing. As such, management tactics that are timed to deplete the food reserves of perennials are most likely to prevent regrowth and spread. For example, the lowest root carbohydrate reserves in Canada thistle occurs just before flowering, when the plant is in the “bud to bloom” stage. Repeated mowing coupled with a competitive crop can deplete carbohydrates reserves from Canada thistle roots and frequent mowing can kill young shoots before they replenish their reserves.

In addition to preventing seed production of perennial weeds, repeated mowing may starve their underground parts. Cutting the leaves and other above ground plant parts reduces biomass accumulation and eliminates the food producing organs as photosynthesis occurs within the leaves, although in some instances, photosynthesis occurs within the plant’s stem. Regrowth that occurs following a cutting drains sustenance from the stored food supply of the weed. As such, repeated mowing can reduce reserves housed in the storage organs. Still it is important to note that using this repeated mowing protocol may not result in the quick death of a perennial weed patch. Effective mowing of large infestations may be a long-term commitment. It may require two or more years of repeated mowing to fully kill a perennial weed stand. The best time to initiate mowing is generally when the underground root reserves of weeds are at a reduced level. This generally occurs when weeds are between full leaf development and flower occurrence. Interestingly enough, these tips related to mowing time can be applied to the timing of herbicide applications for managing perennial weeds as these weeds may also be most vulnerable to herbicides during this stage of their development.

In perennial crops such as forages, weeds and crops are mowed concurrently. The aim is usually to suppress weed competition and seed production while harvesting and managing crop biomass and maintaining pleasing aesthetics. In non-cropland habitats such as field borders typically perennial vegetation is mowed to maintain ground cover and prevent erosion. When crops are planted in rows such as orchards and fruit tree systems, weeds and other vegetation between crop rows are mowed to limit competition with the crop. However, it is important to maintain a stand of “beneficial” vegetation in the inter-row areas as this helps prevent erosion.

Mowing and Cover Cropping

Crops are sometimes planted without tillage into terminated cover crops. Relative to weed control, the main purpose of the “leftover” cover crop residue or mulch is to suppress weeds within the crop row. To this point, weed control in the between row area may be inadequate in a mulch system especially if the crop is not planted at narrow row spacing and/or the biomass of the residue is inadequate. This is more of a problem in the between row area because the crop’s canopy may not contribute to shading the soil in this area. This suggests that overall weed suppression in a mulch system may be more satisfactory if weeds in the between row area can be subjected to an additional management tool. Fortunately, several implements such as high-residue cultivators exist and can be readily used in established crop fields with cover crop residue without jamming (Fig. 5). Mowing can also contribute to weed suppression in a mulch system. Relative to this, a study examining cultivation as a weed suppression tool in a herbicide-killed rye mulch system found that two inter-row cultivations provided adequate weed suppression in dry beans when field margins were mowed to prevent seed production by dandelion, *Taraxacum officinale*.

Fig. 5. A) Cultivator operating in bean field with rye cover crop. Attribute: agriculture.hiniker.com & B) High-residue cultivator. Attribute: Univ. of Delaware Carvel Research & Education Center, M. Walfred

Mowing typically contributes to short term weed suppression. As such, it may only be effective in a fast-growing crop particularly one in which a cover crop mulch has restricted weed establishment. Notwithstanding, in some situations, mowing can reduce the effectiveness of a mulch by speeding up its decomposition. Mowing clips cover crops into smaller pieces which break down more rapidly than thick mats. Differences in mowed residue fragment size and decomposition rate influence the duration of residual weed control from cover crop residue. For example, mowing residue (e.g., barley, crimson clover, hairy vetch, rye, subterranean clover) with a sicklebar at or after the mid- to late-bloom stages suppressed yellow foxtail, common lambsquarters, and redroot pigweed better than flail mowing (Fig. 6). It is believed that this occurred because flail mowing left smaller fragments of residue on the soil surface. Though mowed cover crop residue can provide some weed suppression, the duration and level of weed control by mowed residue is inconsistent and often will not provide good suppression the entire cropping cycle.

Fig. 6. Flail mower cutting a crimson clover/ cereal rye cover crop mixture.

Mowing may also be done in concert with a living mulch (e.g., cover crop that lives the entire duration of the crop life cycle). A study found that mowing buckwheat living mulch between tomato rows after the critical weed control period suppressed weed seed production. The critical period for weed control is the period in the crop growth cycle during which weeds must be controlled to prevent unacceptable yield losses.

A field experiment was conducted in Illinois to study the combined effect of mowing and growing a summer annual cover crop on Canada thistle growth. The study showed that a sudangrass or sudangrass-cowpea mixture alone or combined with mowing suppressed Canada thistle shoot density and mass to less than 20% of initial shoot and mass compared to buckwheat or fallow treatments. However, intensive management must be continued for several years to eliminate patches.

Integrating Mowing with Herbicides

Several investigations have been conducted to examine impacts of combining mowing with other weed management tactics. Relative to this, a between row mowing tactic in combination with herbicide applications and crop canopy shading was evaluated in soybean and field corn. The investigation showed that if properly timed, mowing weeds located in the between row area close to the surface < 3.8 cm (1.5 inch) two or more times can kill or suppress annual grass and broadleaf weeds, such as giant foxtail, common ragweed and waterhemp species. During the investigation, weeds within the soybean rows were managed with herbicides and those that “escaped” treatment were suppressed by early crop shading and competition. It was suggested that this management strategy which consists of a) planting a competitive crop, b) banding herbicide(s) over the crop row and c) mowing weeds between crop rows close to the soil surface before crop canopy closure can be successfully used in competitive crops such as corn, soybean and grain sorghum which closes their canopy and shade weeds early in their cropping cycle. Thus, the implementation of husbandry practices that enhances crop competitiveness with weeds is critical to the success of this management plan.

Unfortunately, between row mowing is not adaptable to most cropping systems especially those grown in very narrow row spacing (e.g., drilled grain) and are weakly competitive and lack the ability to form a closed canopy. In addition, many producers will lack the equipment needed for mowing between crop rows. However, if it can be used in combination with herbicides, it is expected that the amount sprayed can be reduced by 50 percent or more as sprays are only banded within the crop row. Mowing has also been investigated for its ability to supplement herbicides and cultivation in peanuts. After weeds had grown 20 cm (7.9 inch) above the peanut canopy, a tractor pulled rotary mower was used to cut off seed heads just above the canopy 8 and 13 weeks after planting. The mowing prevented peanut shading by bristly starbur, sicklepod and Florida beggarweed. Mowing and applying herbicides in the within row areas of citrus trees are the most widely used weed control practices in Brazil. However, a three-year study in Brazil indicated using ruzi grass, *Urochloa ruziziensis* as a cover crop, combined with within row glyphosate and an ecological mower is a more sustainable IWM option for citrus trees. An ecological mower cuts the cover crop in the between row areas and the resulting residue is launched within the crop rows. Eco-mowing, which involves placing the cuttings from cover crops under the canopies of citrus trees rather than leaving them in the middle rows, is also being researched in Florida.

A study was conducted to test whether integrating early season mowing with a systemic herbicide application would improve the control of perennial pepperweed (*Lepidium latifolium,* Fig. 7). Mowing alone did not reduce weed biomass or its density the following year. However, mowing followed by application of an herbicide to re-sprouting plants reduced biomass in three different environments (high desert, roadside and floodplain habitats). The combination of mowing and the herbicide, chlorsulfuron reduced pepperweed biomass > 99% at all three sites and glyphosate + mowing $\geq$ 80% at two sites, one year after application. It was noted that an initial mowing increased the effectiveness of glyphosate to a level where it became an effective control option.

Fig. 7. Perennial pepperweed (Lepidium latifolium) an invasive noxious weed. Photo: J. N. Stuart (CC).

Advantages of Mowing

Mowing may be repeated over a longer period than some herbicide treatments or cultivation. Further, mowing can be used to suppress weeds that have become too large to be managed with herbicides or cultivation; and mowing has fewer off site environmental effects. Thus, it can be an option where ground cover is desired and herbicide use would be restricted or undesirable. Mowing may also be used in circumstances where concerns exist regarding herbicide contamination of water bodies. Mowing can also be used during situations where weather conditions such as wind speed causes herbicide drift or reduces its efficacy. To this point, mowing is advantageous in highly populated or suburban housing areas where the public is concerned about herbicide exposure. Mowing can be used as a substitute in field conditions where cultivation might damage root systems or lead to soil erosion. Mowing limits erosions caused by wind and water by allowing live vegetation and plant residue to remain on the soil surface. Moreover, mowing is compatible with other soil and plant conservation measures such as no-till practices and land conservation programs. Fields can also be mowed faster following a heavy rainfall event compared to cultivation which requires much drier soil conditions

Negative Aspects of Mowing

Weed species vary in their response to mowing height and frequency and some readily accommodate mowing. "Weeds adapted to mowing tend to grow short, in a rosette form, creeping above the soil surface or show high plasticity and softness of aerial parts and stems and become difficult to mow and also escape hand weeding." Thus, if multiple weed species of varying height persist in a habitat, mowing may become more of a challenge. Mowing can favor weeds that develop and reproduce below the mowing height and repeated mowing of similar weeds can cause a shift: 1) in biotype from an upright growing form to a more prostrate form, and 2) to a community of weeds that are tolerant to mowing. For example, mowing was correlated with differences in plant size and degree of erectness caused by genetic differences between mowed and un-mowed broadleaf plantain (Fig. 8). This suggests that an integrated or more

Fig. 8. Broadleaf plantain (Plantago major). Photo: Stefano (CC)

holistic approach should always be the goal of any weed management program as weeds will adapt to a single management approach. Further, though mowing may reduce aboveground competition, if it fails to kill weeds, they may still compete with crop plants for resources such as space, nutrients and water below the soil. Moreover, weeds that form rosettes or mats and/or grow close to the ground are naturally adapted to mowing. This is why weeds such as dandelion, bermudagrass, crabgrass, goosegrass and buckhorn plantain, once established, are immune to mowing. Additionally, wheel traffic that occurs during mowing can compact some soils such as silty clay loam. Mowing can also be noisy and though vegetation remains on the surface, it may still raise dust.

Summary

Mowing is a relatively inexpensive form of mechanical weed control that can reduce the use of tillage, herbicide and manual weeding. It may serve as an alternative to herbicide and cultivation or part of an integrated approach. However, mowing to manage weeds has not been well studied compared to other IWM tools and is more popular in habitats with perennial stands of vegetation. Consequently, limited information is available on mowing use in crops. As such, it is not adaptable to numerous cropping systems; and partially for this reason, it is used mainly for aesthetic reasons and preventing seed production in perennial stands of vegetation neighboring cropland. Still, research has shown that mowing can be used jointly with other weed management tools such as applying herbicides, cover cropping and growing competitive crops. Mowing may also be used to successfully manage perennial weeds by removing the aboveground plant parts and consequently reducing food reserves in their storage organs. This, however, may take multiple years and the integration of other weed management tactics. Some research has found that combining mowing with herbicides enhances perennial weed control. Still, there are advantages and disadvantages of using mowing as a weed management tool. Mowing generally does not have any negative environmental effects. However, many weeds especially those that grow close to the ground such as buckhorn plantain are naturally tolerant of mowing (Fig. 9). As with any IWM program, it is important to “keep weeds guessing” by utilizing different management tactics; and mowing is no exception to this rule. For example, repeated use of mowing as a single weed management tactic may result in a selection pressure or shift to weed species or genotypes that can reproduce even if repeatedly mowed. These species may overtime become more difficult to manage. As such, in those situations where mowing is practical, one should consider making it part of an overall IWM program. Financial support for the publication of this article is via USDA NIFA EIPM grant award numbers 2021-70006-35384 and NESARE - Research for Novel Approaches (LNE20-406R).

Fig. 9. Buckhorn plantain (Plantago lanceolata). Photo: Clemson University Extension

Upcoming Educational Events

July 2022

- July 20 - Wednesday Water Webinar – Ground water and its Protection. 12:00-12:45pm. For more information and to register: https://go.umd.edu/waterwebinars
- July 20 - Fundamentals of Soil Science and Soil Fertility for Nutrient Management. 12:00-2:00pm. For more information contact Emileigh Lucas at 301.405.2465 or erosso@umd.edu To register: https://umd.zoom.us/meeting/register/tJ0pceigqjIsGdKSP9YMRH3CdNgYmWEVHJJi
- July 22 Tractor College. 10:00am-3:00pm at the Howard County Fairgrounds For more information and to register: mdsoy.eventbrite.com
- July 27 - Women in Agriculture Wednesday Webinar: How to Conduct Market Research. At Noon. For more information and to register: https://go.umd.edu/WIAUME
- July 28 - 2022 Maryland Commodity Classic. 9:00am- 4:00pm at the Queen Anne's County 4-H Park. For more information and to register: http://marylandgrain.org/events/

August 2022

- Aug 1 - ALEI Webinar Series 2022: Choosing Your Farm Business Structure. At Noon. For more information and to register: https://www.eventbrite.com/cc/alei-august-webinar-series-2022-403099
- Aug 8 - ALEI Webinar Series 2022: Business Transitions & Estate Planning Considerations. At Noon. For more information and to register: https://www.eventbrite.com/cc/alei-august-webinar-series-2022-403099
- ·Aug 9 - Maryland Beef Webinar Series: Pasture Management: Stockpiling Tips. 7:30-8:30pm. For more information and to register: https://go.umd.edu/beef-webinars
- Aug 10 - Women in Agriculture Wednesday Webinar: Understanding Herbicide Resistance and Adapting Your Weed Management Program. noon. For more information and to register: https://go.umd.edu/WIAUME
- Aug 15- Tractor College. 10:00am-3:00pm at the Talbot Co. Ag Center. For more information and to register: mdsoy.eventbrite.com
- Aug 15 - ALEI Webinar Series 2022: Figuring Out Farm Business Insurance Needs Webinar. At Noon. For more information and to register: https://www.eventbrite.com/cc/alei-august-webinar-series-2022-403099
- ·Aug 16 - New MDA Animal Diagnostic Lab and Education Tour. 10:00am-1:00pm. For more information and to register: https://www.eventbrite.com/e/new-mda-animal-diagnostic-lab-and-education-tour-tickets-367058250107
- Aug 17 - Wednesday Water Webinar - Top Tips to Care for Your Septic System. 12:00-12:45pm. For more information and to register: : https://go.umd.edu/waterwebinars
- Aug 22 - ALEI Webinar Series 2022: Understanding Tax & Accounting Implications of Business Structures. At Noon. For more information and to register: https://www.eventbrite.com/cc/alei-august-webinar-series-2022-403099
- Aug 24 - Women in Agriculture Wednesday Webinar: Farm Stress Management and Resiliency. At Noon. For more information and to register: https://go.umd.edu/WIAUME
- Aug 31 - 4R & Agronomy Field Day. 8:00am-2:00pm at the Wye Research & Education Center. For more information and to register: https://www.eventbrite.com/e/2022-4r-field-day-tickets-350608799357

New Agriculture Agents Join UMD Extension Team

By Serena Newton

The Agriculture and Food Systems (AgFS) Extension team would like to give a warm welcome to our two new Ag agents, Dwayne Joeseph (Kent County) and Mark Townsend (Frederick County).

Dr. Dwayne Joseph

Agriculture and Food Systems (AgFS) Extension welcomes Dr. Dwayne Joseph to the team. He is the new Kent County Agent who will conduct applied research and educate the public about sustainable agricultural practices. Dwayne received his B.S. in Biology from Grambling State University and then his M.S. and Ph.D. in Plant and Environmental Science at Clemson University. While attending these institutions he earned several grants and scholarships.

Dwayne has years of experience designing and conducting plant science experiments related to weed control and management. Currently, he is researching integrated pest management (IPM) strategies for Maryland with a focus on integrated weed management as a postdoctoral associate for the University of Maryland, College Park Department of Entomology. He has published in several scientific journals and also communicates his findings through oral presentations and other publications, making his work both applicable and accessible. Participation on review committees for the Department of Entomology and Northeast Sustainable Agriculture Research and Education (NESARE) graduate student grant program, and in scientific conferences such as Weed Science Society of America meetings, makes Dwayne stand out as an immensely active member of the agricultural research and outreach community.

The AgFS team looks forward to working with Dwayne as he applies his extensive research background and strong leadership and collaboration skills to improving agricultural practices in Kent County and across Maryland.

Mark Townsend

Agriculture and Food Systems (AgFS) Extension welcomes Mark Townsend as the new Frederick County Agent Associate. He will work with the AgFS team to provide Maryland farmers with the training and resources necessary to run profitable and sustainable operations.

In the spring of 2020, Mark graduated from the University of Maryland, College Park with a B.S in Agriculture and Resource Economics with foci in agribusiness, as well as farm business management and entrepreneurship, and a minor in soil science. This fall he plans to complete a graduate certificate in Geographic Information Systems (GIS) at the University of Maryland, College Park. As a student at the University of Maryland, he was very involved as a student worker for the college of Agriculture and Natural Resources and worked as a Laboratory Teaching Assistant for a Soil Chemistry class.

Mark gained experience overseeing livestock operations as an operations manager for Rocklands Livestock Company and as a farm manager for Clark's Elioak Farm. In these positions he had several responsibilities such as implementing grazing, stocking, and nutrient manage-ment plans, and he applied his knowledge from other accomplishments such as his MDE Erosion and Sedi-ment Control Certification, National Beef Quality Assur-ance Cow/Calf Certification, and passing score on the Soil Science Society of America Fundamentals Exam. As a production intern for a Maryland agri-service busi-ness, he consulted with farmers making decisions about best management practices. He currently conveys infor-mation to central Maryland farmers at biweekly Westmin-ster Grain Marketing Meetings.

Experience working in the field, the lab, the office, and the community makes Mark a valuable addition to the AgFS team.

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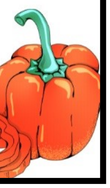

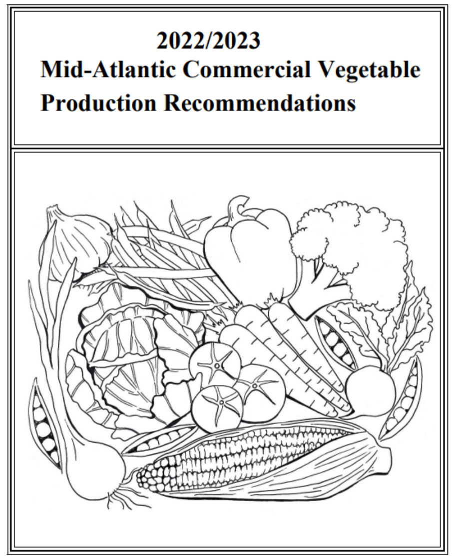

The 2022-2023 Mid-Atlantic Commercial Vegetable Production Recommendations Guide is available for free at https://go.umd.edu/MidVegGuide

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