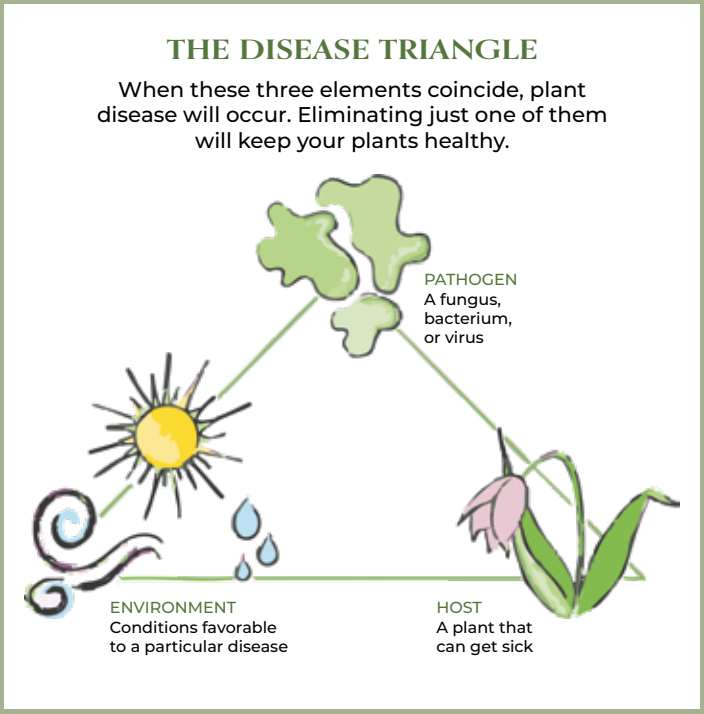
White dahlias under netting

Using the Disease Triangle Mindset to Approach Pest Management

BY KELLY BROWN

This article is part of a larger three-year ecological pest management (EPM) research project at Do Right Flower Farm in Davenport, Calif., funded by a Western SARE grant. In "Addressing Cucumber Beetle in Dahlia, *Fusarium* in Lisianthus, and Blight in Zinnias at Organic Flower Farms," published in *The Cut Flower Quarterly*, Summer 2024, technical advisor Jessica Vaughan and I outlined the background of our project and our specific methods for reducing losses. This article illustrates the broader EPM concept through our experiences, specifically the Pest Triangle.



FARMING IS CHARACTERIZED BY JUGGLING COMPLEXITY. Beyond running our businesses and managing employees, we also manage land, and for flower growers, often an expansive diversity of crops on that land. Every variety we choose brings an array of farming decisions, as well as the annual decision whether to grow it next year. When things aren't going as planned, it can feel daunting to decide our next move, both within the lifecycle of that struggling plant and future treatment of that crop in seasons to come. To complicate matters, our actual control is limited because, well, nature. Many farmers, like me, learned from mentors and coworkers, not in a classroom. I am embarrassed to say, but I would describe my approach to pest control during our first couple of years as avoidance, followed by overwhelm and procrastination, and finally a desperate search for a silver bullet that would magically transform a plant from near annihilation to health.

In the face of obvious failure, I knew I needed a new approach. I quickly sought help from Jessica Vaughan, a local crop scout, working with some of the largest organic vegetable growers in my area, who luckily, wanted to learn more about flowers.

Pest Triangle Basics

Jessica introduced me and my team to the Pest Triangle concept as we were troubleshooting issues in our crops. The Pest Triangle is derived from the Disease Triangle, a concept first described by George Agrios in the classic text *Plant Pathology* (Agrios 1997), which describes how plant pests and diseases result from a dynamic between three factors: host, pest, and environment. As we adjust one factor, the others are affected. Neither exists in isolation, so our solutions to pests and diseases need to consider this larger interplay to be effective. I find that considering this concept from its predecessor, the Disease Triangle, is helpful. Take a common cold virus. For a cold to express itself as such, there must be a host (a body), the pathogen (the cold virus), and also a collection of other factors to tip the host into illness. Is the person's immune system compromised by other stressors? How significant was the exposure to the pathogen? Was there any mechanical barrier present between the host and the pathogen? (Think masks and COVID-19) All of these come together to produce an outcome. It may be possible to isolate factors in a laboratory setting, but that is not the setting for our living world, both for our bodies and the plants in our field. Like the ever-present nature of the cold virus, many pathogens and pests affecting plants are always in our field, and we must figure out how to coexist. That means our choices are less hinged on the presence of a particular pathogen or pest and more on which varieties to grow (host) and how we can tweak the environmental factors affecting those plants.

To further articulate this Pest Triangle mindset in action, I will break down our attempt to reduce losses in zinnias from blight and *Sclerotinia*, dahlias from cucumber beetles and thrips, and lisianthus from *Fusarium* into the pest, environment, and host components and describe how they interplay.

DAHLIAS

PEST: Cucumber beetles (*Diabrotica undecimpunctata*) and thrips (*Frankliniella occidentalis*)

Cucumber beetles and their larvae (rootworm) are prolific at Do Right Flower Farm. While their population varies depending on their lifecycle, here on the Central California coast, we see them for a majority of the year. While conventional growers may have some chemical options to kill these pests, we grow organically and are forced to accept them as our neighbors. Given their pervasiveness, we opted to use a mechanical barrier between cucumber beetles and dahlias, but we were quickly faced with another pest to address.

Like many dahlia growers, our first attempt at mechanical barriers was mesh sachet bags placed over each bud to protect unfurling petals. To our surprise, our bags became overrun with thrips! The mesh of the bags was so fine that the minute pirate bugs (*Orius* spp.), which act as a natural thrips predator, could not reach them, and the thrips found sanctuary on our "protected" dahlias. This was a great lesson in how the presence of a pest isn't a problem unless other environmental factors make the crop vulnerable. We saw thrips here and there, but hadn't sounded the alarm because the minute pirate bugs were keeping their population at bay. This was also a great example of how new pests may emerge because the environment is controlled in an artificial way.

ENVIRONMENT: Mechanical Barriers

After our initial failure with blossom bags, we had to change course quickly. We knew we wanted to continue trying a mechanical barrier, but we needed one that natural predators could enter, and we were interested in something less tedious than the one-by-one cinching of blossom bags. Jessica introduced the idea of netting the entire sections of sensitive dahlia varieties (whites and anemone forms, generally) with a wider-gauge mesh than the bags. We did some research, wrangled some t-posts, and created a little cucumber beetle-free zone—and it worked! This has become our approach to successfully growing sensitive dahlia varieties. In the 2025 growing season, our only change will be addressing petal burn caused by netting touching the outside blooms. We will plant in a single-row formation and add some secondary supports to keep the netting from lying on flowers.

Facing page: Beneficial minute pirate bugs (*Orius* spp.) provide excellent thrips control on dahlias.

Right: Growing dahlias next to a sunflower trap crop reduces cucumber beetle damage, since the beetles prefer the sunflowers.

HOST: (White) Dahlias and Sunflowers

In my previous farm life, I worked at a farm that sold primarily to farmers' markets. We stopped growing white dahlias or others that cucumber beetles especially targeted for two reasons: Our market customers were happy to buy bright colors, and by opting out of sensitive varieties, the presence of cucumber beetles had less impact. On the other hand, Do Right primarily sells to florists who need white flowers for weddings. We have a market incentive to grow them successfully, so simply removing the host (white dahlias) is not a great option for us.

We tweak the host element of the pest triangle dynamic in our dahlias by growing an even more attractive host adjacent to them: sunflowers. Growing a trap crop of sunflower successions nearby so we have continual blooms during our dahlia season attracts hordes of cucumber beetles away from our dahlias and onto the sunflowers. To further encourage the cucumber beetles to choose this alternate host, we hang pheromone lures on our sunflowers.

ZINNIAS

PEST: Blight and *Sclerotinia*

In my experience working in flowers on the Pacific Coast, the latter half of the zinnia season is characterized by bacterial blight. The patch will slowly become peppered with plants melting down until we lose whole sections by fall. During the first year of our research project, Jessica observed that a significant amount of the loss we were experiencing was actually due to *Sclerotinia sclerotiorum*, a fungal pathogen that has some overlapping symptoms of discoloration, wilting, and stem lesions. Our diseases to tackle became both blight and *Sclerotinia*, so our environmental and host decisions needed to expand to include control for both.

ENVIRONMENT: Cultural and Biological Controls

Both blight and *Sclerotinia* proliferate in environments with poor drainage and low airflow, so our primary environmental changes focused on modifying our bed preparation and planting patterns. In the past, we grew zinnias according to the popular practice of dense eight-inch spacing into weed fabric popularized by Floret and other teachers. In our efforts to increase airflow and drainage, we have made significant moves away from this planting method. We start with tall beds, nearly strawberry height, to ensure good drainage even during surprise late-season rains. We plant only two rows at one-foot spacing in uncovered beds, providing ample airflow between plants and beds. This change has resulted in a nearly 40% reduction of blight and *Sclerotinia*. Weed fabric helps the soil retain moisture, which is great for water conservation, but unfortunately, it is also a setup for water-loving pathogens to take hold in a moister, cooler environment like ours.

Another environmental change we made to address blight and *Sclerotinia* in zinnias is on the biological front. Throughout their life cycle, we inoculate our zinnia transplants with *Trichoderma* in the sowing mix, through a plug dunk before planting, and through the drip lines during monthly chemigation. *Trichoderma* is a beneficial fungus known to suppress soil-borne disease, and while we have not isolated this environmental change to know for sure of its effectiveness, we feel it's a small effort to help fortify our valuable plants.

A zinnia infected with *Sclerotinia.*

HOST: Zinnias, But Which Ones?

We grow several types of zinnias from large to very small: Giants, Zinderellas, Queens, Crestos, Peruvians, new-to-the-market Pastels, Zaharas, Profusions, and Stars. While all have benefited from our environmental changes to reduce blight and *Sclerotinia*, one type has not made the same turnaround: white, yellow, and orange Star zinnias. Given how successful our environmental changes have been at reducing losses in all other varieties, we have decided to stop growing sensitive Star varieties. Sometimes, removing the host is the most responsible way to approach a pervasive problem.

LISIANTHUS

PEST: *Fusarium* (and being rootbound)

Our first two years of growing lisianthus resulted in near-total meltdown. A tissue sample confirmed that these plants were suffering from *Fusarium*, a common soil-borne pathogen. In our third year overall and first year of this project, we experienced significant loss due to rootbound plugs as well as *Fusarium*. It was a rookie mistake on my part not to take note of the state of the plugs after planting was delayed due to an unseasonably wet winter. While being rootbound is a cultural condition, not a pest, lisianthus cannot survive it, and it became a significant factor to contend with nonetheless.

ENVIRONMENT: Cultural and Biological Controls

Like blight and *Sclerotinia* in our zinnias, *Fusarium* proliferates with low airflow and poor drainage. Our cool, moist coastal climate presents a challenge for vulnerable plants like lisianthus. During the first year of this project, we set up our lisianthus beds the same way we did our zinnias: tall with wider spacing than the typical tight spacing that is usually recommended. We also inoculated the plants with *Trichoderma* at the same frequency as the zinnias. When we experienced a similar meltdown, we tested the tissue, soil, and water, confirming the presence of *Fusarium* in both the tissue and soil, but not in the water.

Ordinarily, we might consider the positive soil test enough to abandon this crop for future production, but for the sake of research, we experimented with planting at a similar low density into purchased soil medium in crates. Unfortunately, we experienced the same symptoms, and a lab confirmed this was due to *Fusarium*. The lab shared that they see an increasing amount of *Fusarium* in purchased plugs, which explains the contamination. Despite our efforts to affect the environment our lisianthus was growing in, the combination of our climate and infected purchased plugs is too much for us to outrun this pathogen.

Disease issues with lisianthus resulted in its removal from Do Right's crop selection.

HOST: Purchased Plugs

Technically, we could make a last-ditch effort and grow our own lisianthus transplants from seed and reduce the chances of *Fusarium* presence by planting in containers with clean soil medium. But lisianthus is notoriously tricky to grow from seed, taking daily babying, heat mats, moisture domes, and perfect humidity. Due to the remoteness of our farm, this kind of attention is not feasible in the dead of winter. Through this experimentation and subsequent failures, we have confidently decided that lisianthus is not the crop for us.

Using the Pest Triangle mindset to address losses at Do Right Flower Farm brings the interplay between host, pest, and environment to the forefront rather than falsely attempting to isolate each factor. Many important farming lessons have come from this approach that clarify both where to direct our effort and how to act in a way that is responsible for the larger ecology. What is unique about our farm that encourages certain pests? Can we change the environment in which our plants grow to counteract those characteristics? Will those changes potentially encourage other pests and diseases? When is it time to step away from certain varieties that act as stubborn hosts? The days of avoiding pest damage until it's beyond help have been replaced with close monitoring by our crop scout, Jessica Vaughan, and our team so we can be responsive to subtleties as they arise. ■

ABOUT THE AUTHOR AND DO RIGHT FLOWER FARM:

Kelly Brown began their farming career in 2009, after a four-year stint as a bike messenger post-college where they studied feminist and community studies. They remain invested in justice work and see their impact as a leader and land steward as a continuation of it. Kelly started Do Right Flower Farm in 2021 and now employs a team of skilled farmers that make this beautiful four-acre experiment hum. Follow along on Instagram at @dorightflowers or online at dorightflowers.com.

ABOUT JESSICA VAUGHAN:

Jessica Vaughan is a practicing agronomist and owns Vaughan Grower Consulting, which provides crop scouting services to greenhouse and field growers on the central coast of California and crop troubleshooting services throughout the U.S. and Canada. Follow along on Instagram at @vaughangrowerconsulting.com.

Jessica Vaughan (L) and Kelly Brown presenting their research at the farm.

REFERENCES

Agrios, G. 1997. *Plant Pathology* (4th ed.). Academic Press.