KANSAS STATE UNIVERSITY RESEARCH

Editors' Note: This is the sixth in a seven-part series on Extension, teaching and research programs being performed at Kansas State University.

Intumescences: A Physiological Disorder of Greenhouse-Grown Crops

WHAT ARE INTUMESCENCES, AND HOW CAN YOU PREVENT THEIR OCCURRENCE ON YOUR CROPS?

By Joshua K. Craver, Chad T. Miller and Kimberly A. Williams

Producing high-quality plants is not always an easy task. The great diversity of ornamental and food crops grown in greenhouses results in the need for growers to provide different cultural practices and maintain a variety of production environments. Greenhouse producers must monitor and make decisions about fertilization, irrigation and temperature, for example, with the goal of optimizing plant production. However, sometimes plants respond to these environmental parameters with abnormal growth and development.

One of the most peculiar physiological disorders observed on greenhouse crops is the development of intumescences. These small, bump-like protrusions are commonly found on crops in the Solanaceae family (such as 'Maxifort' tomato and some pepper and potato varieties), *Cuphea spp*., and *Ipomoea batatas*, or ornamental sweet potato vine. This list of susceptible species is by no means complete, but rather a small sampling of crops on which intumescences have been previously studied. Within these species, one cultivar may display resistance to the disorder while another cultivar is routinely susceptible. Such repeated observations across species lead to the conclusion that cultivar-specific genetics has some role in the development of this physiological disorder.

Figure 1. *Entire leaf of* ipomoea batatas *'Ace of Spades' covered with intumescences (Photo: Joshua Craver).*

Anatomy and Physiology of Intumescences

Intumescences are a physiological disorder

Intumescences are a physiological disorder that manifest themselves as abnormal growths on the surface of leaves, petioles and stems of affected plants.

that manifest themselves as abnormal growths on the surface of leaves, petioles and stems of affected plants (Figure 1). These growths are small groups of cells that appear as translucent protrusions that can rapidly spread across plant tissue. Because there is no evidence suggesting a pathogenic cause, the disorder is considered 'physiological.' In other words, the abnormal cellular growth is the result of the environmental conditions or stimuli in which the plants have been grown.

Upon closer examination, one can see that intumescences are actually swollen epidermal cells. These cells appear to have undergone cell enlargement, rapid cell division, or a combination of these two responses, resulting in the protruding growths on the surface of plant tissues. Figure 2 shows a close-up of cells displaying this disorder.

Figure 2. *Close-up of single intumescences on ornamental sweet potato vine (Photo: Joshua Craver).*

Causative Factors

There have been many attempts to define and explain why or how intumescences occur. A few examples of factors that researchers have attributed to causing the disorder include chemical injury, nutritional status, hormones, genetics, air quality, light quality and intensity, temperature, and mechanical injury. Currently, there is no concrete evidence supporting any one specific cause. One of the first and most often cited explanations for this disorder involves water relations within the plant. More specifically, the hypothesized cause is excess water coupled with high levels of humidity. The general idea behind the theory is that as the uptake of water by the plant exceeds its rate of transpiration, or the plant's ability to move water out of its cells, epidermal cells expand due to water levels building up in the leaf. The resulting elongated and swollen cells are observed as intumescence development on the leaf surface. While this explanation may seem logical, plant or root medium water status has not been shown to be responsible for development of the disorder. Much of the research concerning intumescences has suggested other potential causative factors, which are listed above. As more research has been conducted, conflicting evidence has arisen regarding what is behind this disorder. Because there is no single defined causative factor that is consistently associated with intumescence development, there is also no specific remedy to avoid or abate its occurrence during production.

Tying Ends Together

With such a wide variety of susceptible crops and potential causes, it is interesting to find that there is a common factor related to almost all cases of intumescence development. Nearly all of the documented cases have occurred when plants were grown in controlled environments — either greenhouses or growth chambers. There have been very few instances where intumescences were found to develop in outdoor scenarios. While indoor production environments are meant to simulate or provide optimal conditions for plant growth, one of the major differences between indoor and outdoor environments is light quality, which has been the focus of several research projects conducted at Kansas State University.

Many greenhouse glazing materials block ultraviolet (UV) wavelengths of light. For example, all greenhouse poly includes a UV-block additive

Figure 3. *UV-B light treatment of ornamental sweet potato (Photo: Joshua Craver).*

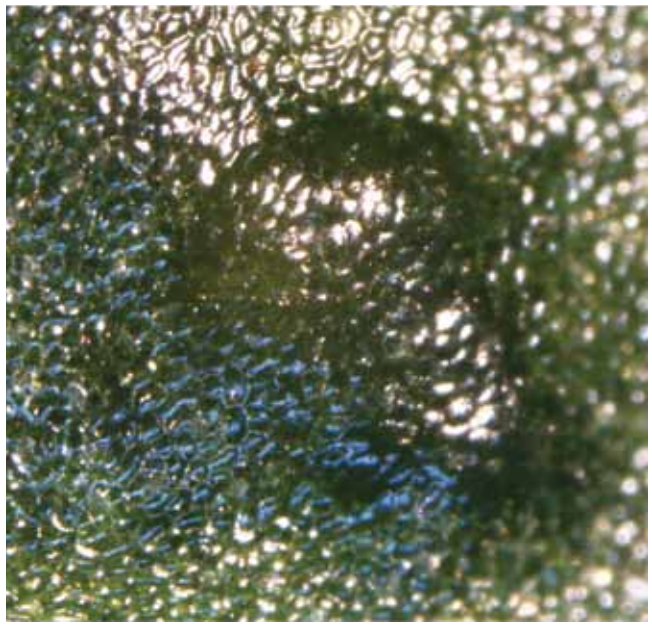
to slow degradation and extend its useful life. Thus, the lack of UV transmission may be the missing link in explaining what causes intumescence development.

In the Kansas State University greenhouses, we formulated a study to investigate the question, "Does UV light play a role in the development of intumescences on ornamental sweet potato (Ipomoea batatas)?" (Figure 3). What we found was that plants exposed to UV wavelengths did not develop intumescences, although there was an occasional intumescence observed. On the other hand, plants grown under typical greenhouse conditions, where UV was blocked, were more susceptible to intumescence development. These findings provide some insight into this complicated physiological response.

A Disorder with Many Names

Adding to some of the mystery and confusion is the inconsistency surrounding intumescence nomenclature. This is due to the wide array of names used interchangeably in the literature when referring to intumescences and related disorders. Some of these commonly used names include: oedema, edema, genetic tumors, galls, leaf lesions, excrescences, enations and neoplasms. While these terms refer to similar plant responses, there are certainly multiple disorders with different causative factors that are being addressed. Probably the most common misnomer is the interchangeable use of oedema and intumescence. Many people believe that these names refer to the same disorder. However, it is probable that what is being observed is the result of completely different causative factors and physiological responses.

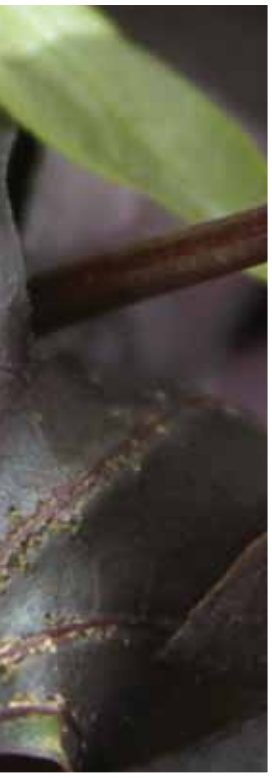
Oedema is commonly found on the underside of geranium leaves — more commonly, ivy geranium (*Pelargonium peltatum*). The disorder appears as swollen green bumps on



Clockwise from top left: ***Figure 4.*** *Oedema on ivy geranium prior to cell collapse (Photo: Nicole Rudd);* ***Figure 5.*** *Brown lesions on the lower surface of ivy geranium leaves (Photo: Joshua Craver);* ***Figure 6.*** *Desiccated intumescences along leaf veins on ornamental sweet potato vine (Photo: Chad Miller).*

the leaf surface that ultimately develop into brown lesions. Previous research conducted at Kansas State University showed that this disorder was due to the swelling of epidermal cells (Figure 4) that eventually collapse, leaving a sunken brown lesion in their place (Figure 5). By comparison, we have found that as intumescences develop they protrude outward and are noticeably translucent. Additionally, intumescences do not rupture or collapse. Rather, the cells increase in size and proliferate until they eventually desiccate and fall off the leaf surface (Figure 6).

In terms of causative factors, both intumescences and oedema remain elusive. While atmosphere, plant and root medium water relations have been shown to play a role as causal agents for oedema, there is still some discrepancy concerning the specific mechanism involved.



Alternatively, intumescences appear to occur in response to a lack of UV light, but the disorder cannot be fully explained by this single environmental variable. By pointing out these differences in the disorders, we hope that growers frustrated by either disorder can more accurately identify which one their crops suffer from and trace back to a shorter list of causative factors.

Impact and What to Do

So with all this information, it begs the question, why should a grower care about the prevention of intumescences on their crops? It is well known that aesthetics play a crucial role in ornamental production. Any reduction in aesthetic value can reduce salability as consumers may be hesitant to buy a plant that looks diseased or injured. Therefore, it is important to ensure these crops are in the best physical condition possible.

Aesthetics aside, intumescences can also dramatically alter physiological processes in the plant. As intumescences form across the leaf surface, especially in severe cases (Figure 1), photosynthetic activity may decrease as plants slowly lose leaf area available for this process. Additionally, as intumescences form on the leaf veins and stems, it is unclear if water and nutrient transport may also be affected in the plant. In cases of severe intumescence development, gradual senescence of leaf tissue can occur.

Additional studies investigating intumescence development are ongoing to further understand the causative factors involved in this disorder. Until we better understand the physiological mechanism behind how the quantity, quality and dosage of UV light influences intumescence development, no recommendation to avoid the disorder can be prescribed. A cultivar trial is currently in the works, as it appears that some cultivars are more susceptible to the disorder than others; thus, cultivar selection is a major consideration in 'preventing' intumescence development. With further research, we will hopefully be able to better inform growers on how they can avoid this disorder.

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