

The Use of a Standardized Set of Terms to Describe Plant Disease Resistance in Environmental Horticulture

White Paper



Horticultural
Research Institute

The  AmericanHort Foundation

Introduction

AmericanHort is the primary national trade organization representing environmental horticulture industries. With a combined history of over 220 years of service to the horticulture industry, AmericanHort supports nearly 14,000 member and affiliated businesses that include plant breeders, greenhouse and nursery growers, garden retailers, distributors, interior and exterior landscape professionals, florists, students, educators, researchers, manufacturers, and all of those who are part of the environmental horticulture industry market chain. Greenhouse (including floriculture) and nursery plant growers represent the largest share of our active member firms.

Crops represented in environmental horticulture include trees, shrubs, flowers, and plants used in residential, commercial, municipal, and other landscapes and buildings, and for environmental, restoration, and reforestation purposes, as well as cut flowers and greenery. They also include the vegetative planting stock for commercial and home fruit tree fruit, nuts, berries, small fruits, and vegetable production. Floriculture and nursery represent roughly one third of the total value of

specialty crops produced in the US and roughly ten percent of the total value of crop agriculture.

The environmental horticulture industry consists of a variety of business models, from large, multimillion-dollar companies to small, Mom-and-Pop businesses, with the vast majority being independent operations. With this high degree of diversity comes a low degree of standardization of business practices; no two businesses are the same. All aspects of management may differ, including what pot style and sizes are used in container production, what type of irrigation is employed, and many, many other aspects. AmericanHort helps to lead this diverse group of businesses in certain ventures of common interest.

AmericanHort prides itself in listening to industry needs and relies on stakeholder input to drive its focus and efforts, including the industry-initiated movement to standardize the terms used as marketing tags on newly released plant material in reference to specific diseases and/or abiotic stresses.

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Background

Plant disease management and abiotic stresses continue to be key issues facing environmental horticulture. Diseases such as impatiens downy mildew (causal agent, *Plasmopara obducens*), boxwood blight (causal agent, *Calonectria pseudonaviculata*), and rose rosette disease (caused by the rose rosette virus) are examples of diseases with recent devastating impact on the industry; there are many others. Drought stress, salt accumulation, and cold exposure are three examples of common abiotic (non-living) stresses impacting plant health. Homeowners, consumers, and gardeners of plants for planting are more likely to be repeat customers if they experience success. A plant that succumbs to disease or requires constant fungicide applications, or one that easily succumbs to abiotic stresses in its environment is often considered undesirable.

Disease resistance and tolerance in plants contribute greatly to plant health and ultimately to the success of environmental horticulture. Plant selection has occurred for thousands of years, since likely near the beginning of civilization. Plant selection and breeding are key tools to manage plant diseases and abiotic stresses, such as drought, salt, cold, etc. When successful, plant breeding efforts that incorporate disease resistance or tolerance provide plants that require fewer pesticide applications and are more sustainable for both producers and homeowners/end users.

Reliance on breeding to resolve production and management issues will likely increase, given new, rapidly developing novel biotechnology techniques and applications. Often called precision breeding, advanced techniques that mutate, insert, delete,

replace, or silence genes or their promoters will likely be adopted by environmental horticulture breeders in time. One example of these techniques, CRISPR/Cas9, has gained attention for its low cost, precision, and efficacy. This is in addition to other, transgenic approaches that insert novel genes into a plant to express new trait(s). Transgenic approaches, however, tend to be avoided due to regulatory constraints and problems with consumer acceptance. Regardless, these techniques and others are rapidly changing the plant breeding world and will more rapidly develop plants with disease and/or abiotic stress tolerance.

As more new plants are anticipated to be released targeting disease and/or abiotic stress management in environmental horticulture, the industry will be faced with how to best represent these traits to customers and set their performance expectations. Often the terms **resistance** and **tolerance** are used interchangeably, and oftentimes **resistance** is mistakenly thought to equal **immunity**. Industry representatives requested an AmericanHort-led effort to explore an industry-wide adoption of specific terms to be used in the event of a new plant release when describing disease resistance and/or tolerance to abiotic stresses to help avoid unsubstantiated and misleading claims.

Proposed Solution

A task force was convened of volunteer industry leaders to address the issue and discuss potential solutions. The group first acknowledged a desire to move forward with a set of standardized terms for recommended, industry-wide use. Potential confusion surrounding the definitions of commonly used terms exists and needed to be addressed. The terms ***tolerance***, ***resistance***, and ***immunity*** are used to describe a host plant's response to infection and are often used mistakenly and/or interchangeably to describe a plant's response to a stress.

The International Seed Federation (ISF) and American Seed Trade Association (ASTA) follow a set of guidelines for ornamental and vegetable seed production that provided an ideal model for the environmental horticulture industry. The guidelines used by ISF and ASTA are relevant for both ornamental and vegetable seed production. Their program centers around a published set of definitions of four terms to be used when describing a plant's reaction to a pathogen to customers: susceptibility, high resistance, intermediate resistance, and immunity. Tolerance is used only to describe a plant's response to abiotic stresses.

Some plant-pathogen complexes for edible crops have undergone development of a differential set of hosts and reference pathogen strains by a designated outside, third party: the Collaboration for Plant Pathogen Strain Identification (CPPSI). CPPSI is housed at the University of California – Davis and funded directly by leading seed production companies. Research on each plant-pathogen

complex requires approximately three years' time from start to finish to fully describe differentials. For each disease complex, pathogen strains and races are identified, followed by differential host reactions for each pathogen strain. Upon conclusion, a white paper is released with these details shared to the seed trade at large; this information is available publicly on the CPPSI website. Each host-pathogen complex is further reviewed on a five-year interval for changes, additions, and updates. White papers for melon Fusarium wilt, pepper bacterial spot, spinach downy mildew, and tomato mosaic virus are currently available.

AmericanHort recognizes that other definitions exist for the terms selected for use besides those used by ISF and ASTA. Since many businesses in environmental horticulture overlap with the seed trade industry, particularly plant breeders, the task group felt that it would be strategic to develop a program in alignment with that used by ISF and ASTA in order to provide practical, workable terms for environmental horticulture.

To that end, a set of definitions was created with input from the breeding community of both floriculture and woody plant material and the research community. The definitions pertain to all crops, including annuals, herbaceous perennials, and woody plant material.

Definitions

AmericanHort recommends the environmental horticulture industry use the terms **immunity**, **susceptibility**, and **high** or **intermediate resistance** to describe the reaction of a plant to pathogens, whereas the term **tolerance** should be used to describe abiotic stresses in marketing communications with customers. The definitions provided below are meant to provide clarity for claims made of newly released plant material relative to a particular disease(s) or abiotic stress(es) at the time of testing. Changes in resistance are not covered under the original claim. When using these terms, companies are advised to specify which disease it references, and when possible, the location and source of testing.

Immunity is when a plant cannot be infected by a given pathogen.

Resistance is the ability to exclude, hinder, or overcome the effects of a specified pathogen; the opposite of susceptibility. Resistant varieties may exhibit some disease symptoms or damage under heavy pathogen pressure and/or highly conducive environmental conditions. Two levels of resistance are defined: high and intermediate.

1. **High Resistance** describes plant varieties that can be infected but restrict the growth and/or development of the specified pathogen and/or the damage it causes.
2. **Intermediate Resistance** describes plant varieties that restrict the growth and/or development of the specified pathogen and/or the damage it causes but may exhibit a greater range of symptoms or damage compared to highly resistant varieties. Plant varieties with intermediate resistance will show less

severe symptoms or damage than susceptible plant varieties when grown under similar environmental conditions and/or disease pressure.

It is to be noted that if resistance is claimed in a plant variety it is limited to the specified biotypes, pathotypes, races or strains of the pathogen that it has been tested against. For this reason, AmericanHort recommends each company specify the disease(s) relative to the resistance claims. If possible, the location and source of testing should be included as well.

If no biotypes, pathotypes, races or strains are specified in the resistance claim for the variety, it is because no generally accepted classification of the cited pathogen by biotype, pathotype, race or strain exists. In this case resistance is only claimed against certain, not further specified, isolates of that pathogen. New biotypes, pathotypes, races or strains that may emerge are not covered by the original resistance claim.

Susceptibility is the inability of a plant to resist or restrict the invasion of a pathogen; the opposite of resistance.

Tolerance is the ability of a plant variety to endure abiotic stresses without serious consequences for growth, appearance, and yield.

The environmental horticulture industry should avoid using the term tolerance to describe a plant's response to biotic stresses. Tolerance should only be used to describe the ability of a plant variety to endure abiotic stresses without serious consequences for growth, appearance, and yield.

Third party testing to verify marketing claims may be beneficial; however, it may also be cost prohibitive for the environmental horticulture industry. The sheer diversity of new plant introductions each year is vast, and associated diseases are diverse as well. Many firms invested in plant breeding conduct their own trials to substantiate and verify resistance and/or tolerance claims. AmericanHort strongly supports these continued efforts and encourages transparency when reporting them.

Disease specifics should be included on the marketing claim. For example, a tag on an impatiens plant should state 'High Resistance to Impatiens Downy Mildew' as opposed to 'High Resistance to Disease.' The location and source of testing may be helpful information to include as well.

Benefits & Conclusions

Adoption of this language will help resolve confusing assertions and unify the environmental horticulture industry in making marketing claims regarding plant resistance to biotic (diseases) and tolerance to abiotic (environmental) stresses. Once the industry as a whole follows the above guidelines, customer's expectations will be better aligned with plant performance. Ultimately, this leads to increased confidence, among both producers and customers, and growth of the industry. Therefore, AmericanHort encourages all breeders and those involved in new plant introductions within environmental horticulture to follow this guidance.

The definitions were created with an eye towards staying in alignment with the seed trade organizations, ISF and ASTA, to enable continuity and ease of use for companies involved with both breeding of new plant varieties and seed introductions.

AmericanHort acknowledges that disease resistance can break down over time. Often a pathogen evolves and can overcome resistance. Therefore, any resistance or tolerance claim(s) made reflects the status of a plant at the time of testing. Changes in resistance over time are not covered under the original claim.

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