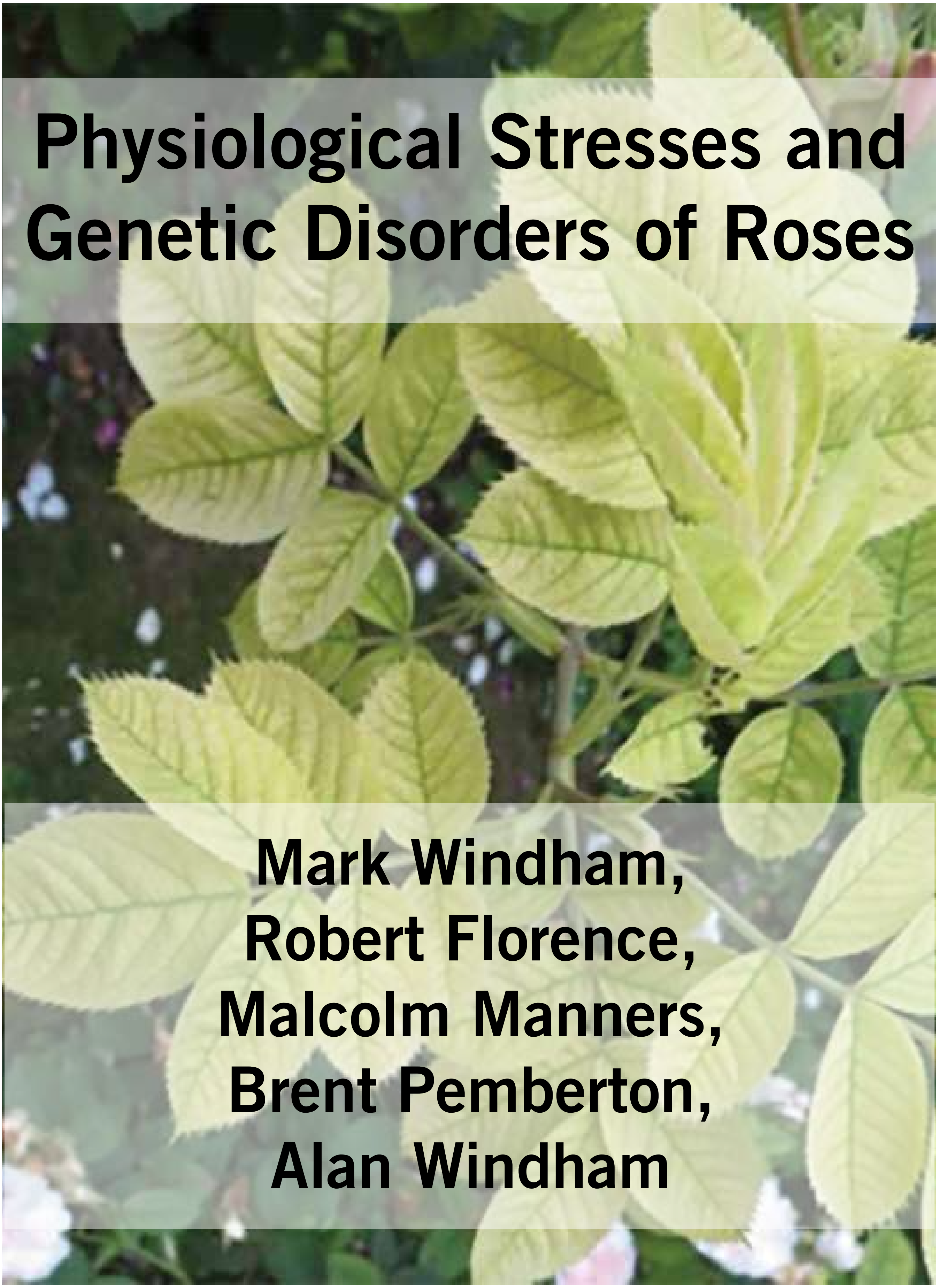

Physiological Stresses and Genetic Disorders of Roses

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INTRODUCTION

Rose abiotic health issues are not caused by plant pathogens and are considered disorders and not diseases. They are usually caused by environmental conditions (cold, heat, lack of or too much water), landscape positioning, soil *p*H or nutrient availability, genetic abnormalities, pesticide damage, etc. Environmental conditions can be managed to some degree, but these are crucial to explore and know before planting. Landscape position, soil *p*H, and nutrient status can be evaluated and addressed before planting. Genetic abnormalities may present themselves after planting. Pesticide damage can be minimized by thorough reading in all pesticide labels before application.

Landscape position and its effects on the plant can be influenced by slope, soil texture, proximity to buildings, and sun exposure. Plants at the base of a slope in poorly drained soils may have their roots saturated for too long. Plants in poorly drained soils at the top of a soil may also have waterlogged roots as the plant is effectively in a clay pot. When roses are grown near masonry or buildings with reflective surfaces, they may experience heat stress during periods of hot weather. Roses in these circumstances may be stunted, have chlorotic/necrotic foliage, have few blooms and have stunted root systems.

Soil *p*H and nutrients can be addressed with a soil test every two to three years. Beds can be tested as one sample, if they have all received the same soil amendments, fertilizer, and lime over time. If some beds have been managed differently than others, then we suggest testing the beds separately. Soil tests for rose beds will reveal the soil *p*H and the various nutrient levels. In some cases, it can be difficult to choose a fertilizer that will meet the exact needs for all nutrients. In these cases, one may have to buy one, two or three separate fertilizers to meet the demand of their soil. The soil *p*H may need to be adjusted up or down as well. Soil testing can aid in determining how much of an acidifying agent (elemental sulfur, aluminum sulfate, others) or a liming agent, to raise *p*H, may be needed.

In some circumstances, the health issue is not due to a plant pathogen or an abiotic stress. The phenomenon is due to a genetic abnormality (mutation). Mutations can be difficult to diagnosis because they are based on symptoms and not genetic testing. Mutations can be distracting - tissue proliferation, viewed as a curiosity – fasciation, or desirable – variegation. Mutations can be stable, persist through multiple generations of vegetative propagation (propagation via cuttings or grafting), or unstable, disappear or become less pronounced from one vegetative generation to the next.

NUTRIENT DISORDERS

Nutrient disorders may be the result of too little or too much of a nutrient. Some nutrients will be more or less available in soil solution, depending on the soil *p*H. In high *p*H soils (those higher than 7.5 or so), roses may display symptoms of iron or manganese deficiency. In low *p*H soils, iron may be readily available to roses, but aluminum may become too available causing aluminum toxicity. Neither of these nutritional or toxicity issues are related to the total amount of the nutrient in the soil but are related to how much of the total nutrient is in the soil solution.

While soil *p*H can affect nutrient availability, some nutrients can affect each other's plant uptake. This can be seen with phosphorus. Too much phosphorus may interfere with zinc uptake. Phosphorus may be naturally high in a soil (from parent material) or may be elevated from manure, or fertilizer applications over time. Phosphorus is generally considered an immobile soil nutrient as it is retained by iron and aluminum in clay minerals. Clay, or loam soils will retain phosphorus in the surface, while deep sands may allow phosphorus to move down the soil profile. From these examples, it becomes clear that nutrient deficiencies and toxicities are complex subjects. The interactions of nutrients in soils and pH may make a diagnosis of an abiotic issue difficult.

Soil nitrogen may be affected by amendments that increase friability of soils (looseness of soil to increase aeration and water movement) in rose beds. Rose bed soil may be amended with chopped leaves, compost, or the old mulch is incorporated into the rose bed soil. Depending on the carbon and nitrogen content of organic matter added, soil nitrogen may be used in the short term by microbes, preventing plants from getting enough nitrogen. The higher the carbon to nitrogen ratio of the organic matter added, the more likely microbes will use available soil nitrogen before plants can take it up.

Not all nutrients are needed in similar amounts by plants. Mineral nutrients can be divided into three categories base on need. Primary-macro (nitrogen, phosphorus, potassium), secondary-macro (calcium, magnesium, and sulfur) and micro-nutrients (boron, zinc, iron, copper, manganese, cobalt, nickel, molybdenum, chloride) are needed in different amounts.

MACRONUTRIENTS

Nitrogen deficiency

The most common symptom of nitrogen deficiency is yellowing of leaves. Usually leaf veins and tissues between veins are uniformly yellow (chlorotic) (Fig. 1). The deficiency is observed in older leaves first and leave drop may occur. This symptom can be confused with other plant problems. For example, chlorotic leaves and leaf drop (defoliation) are common symptoms for the biotic disease black spot and the abiotic disorder brought on by a lack of direct sunlight.

TOP, RIGHT: Fig. 1. Nitrogen deficiency. Note the general yellowing (chlorosis) of the leaves (veins and interveinal tissues).

Potassium

Plants with potassium deficiency initially have leaves that are lightly chlorotic. Leaves will develop reddish spots or blotches. Leaf edges will be burnt or necrotic (Fig. 2). Potassium deficient roses are usually stunted and have poor flower development.

BOTTOM, RIGHT: Fig. 2. Rose foliage with potassium deficiency. Note the reddish spots and necrotic leaf edges. Photo credit: www.Treloarroses.com.au.

Phosphorus

Dark green leaves characterize phosphorous deficiencies in younger leaves.(Fig. 3). Leaves are smaller and plants are stunted. Older leaves may be lighter in color and may become completely yellow. Some older leaves may turn purple. Flower buds can be distorted and smaller. Plant maturity can be delayed. Phosphorus toxicity is common in older rose beds. Plants are stunted. Excessive phosphorus may cause zinc deficiency. On high *p*H soils, iron and zinc may interact with phosphorus causing them to be less available to roses resulting in deficiency symptoms. Foliar sprays with iron and zinc are beneficial, but only work for a short time before applications must be repeated.

TOP, RIGHT: Fig. 3. Young leaves are darker and older leaves are lighter than normal with a phosphorus deficiency. Photo credit: https://www.ars.usda.gov/ARSUser Files/50820500/GPRG/2011 PublicationsandSummaries CharacterizationOfNutrientDisordersOfPot RoseKarinaParade [Article].pdf

Calcium

Other than initial mild chlorosis, center of leaves remains green with calcium deficiencies. Edges of leaves may become necrotic and curl. Stems collapse and may exude clear liquid (Fig. 4). Plants are stunted.

TOP, RIGHT: Fig. 4. Stems of plants with calcium deficiency may collapse. Plants are stunted. Photo credit: https://www.ars.usda.gov/ARSUserFiles/50820500/GPRG/2011PublicationsandSummaries/CharacterizationOfNutrientDisordersOfPotRoseKarinaParade[Article].pdf

Copper

With copper deficiency, leaves are smaller than normal with interveinal chlorosis. Leaves may become curled and distorted (Fig. 5).

SECOND, RIGHT: Fig. 5. Leaves from plant deficient for copper are smaller (center and right) when compared to leaves of healthy plant (left). Leaves from deficient plant also have interveinal chlorosis and leaf curling. Photo credit: University of Florida.

Magnesium

Bushes with magnesium deficiency grow normally but have interveinal chlorosis in older leaves. Over time, chlorotic areas may develop white blotches (Fig. 6) which eventually become necrotic. Leaves drop prematurely from the bottom of the bush.

THIRD, RIGHT: Fig. 6. White blotches that eventually become necrotic develop in chlorotic leaf tissue on plants with magnesium deficiency. Photo credit: https://www.ars.usda.gov/ARSUserFiles/50820500/GPRG/2011PublicationsandSummaries/CharacterizationOfNutrientDisordersOfPotRoseKarinaParade[Article].pdf

Sulfur

Foliage becomes pale at top of bushes with sulfur deficiency (Fig. 7). The youngest leaves may develop interveinal chlorosis.

BOTTOM, RIGHT: Fig. 7. Pale, chlorotic foliage with interveinal chlorosis of youngest leaves is symptoms of sulfur deficiency. Photo credit: https://www.ars.usda.gov/ARSUserFiles/50820500/GPRG/ 2011PublicationsandSummaries/CharacterizationOfNutrientDisordersOfPotRoseKarinaParade [Article].pdf

MICRONUTRIENTS

Some minor nutrients are needed in higher amounts than others. Meso nutrients are minor nutrients required in higher amounts than trace nutrients. Meso nutrients include magnesium, calcium and sulfur. In this document, meso and trace nutrients are clumped together and will be covered in alphabetical order.

Boron

New foliage may be malformed and mottled to yellow in bushes with boron deficiencies (Fig. 8). Flowers are often bullnose (blooms are balled and not open). Plants are stunted with fewer flowers. Symptoms can be confused with iron or zinc deficiencies. Compared to many ornamentals, roses are fairly tolerant to boron. However, if levels of boron become high enough for toxicity, leaves become yellow along leave margins (Fig. 9). Margins may develop soaked spots that become necrotic. Stems will have fewer leaves than normal and terminal buds may die. Boron can easily be over applied leading to toxicity. Before applying boron fertilizer follow soil test recommendations, or product labels.

TOP, RIGHT: Fig. 8. Foliage of roses suffering from boron deficiency mildly chlorotic and mottled. Photo credit:https://www.ars.usda.gov/ARSUserFiles/50820500/GPRG/2011PublictionsandSummaries/CharacterizationOfNutrientDisordersOfPotRoseKarinaParade[Article].pdf

MIDDLE, RIGHT: Fig. 9. Boron toxicity is denoted by chlorotic (yellow leaf margins) and usually occurs when pH is too low. If the deficiency become chronic, chlorotic areas can become necrotic.

Iron

Youngest leaves turn chlorotic with iron deficiency. In less than two weeks, interveinal chlorosis of foliage is apparent throughout the entire plant (Fig. 10). In severe cases, stems may turn yellow. Iron deficiency is often dependent on soil pH with the higher the pH level, the greater the severity of iron deficiency.

BOTTOM, RIGHT: Fig. 10. Symptoms of iron deficiency include interveinal chlorosis.

Manganese

Symptoms of manganese deficiency resemble those of iron deficiency but may become more vivid. After several weeks, dark green coloration of veins may expand into surrounding tissues causing a green border appearance around veins (Fig. 11). White to tan spots may appear in interveinal chlorotic area. Deficiency can be dependent on soil *p*H with the higher the *p*H level, the greater the severity.

BOTTOM, RIGHT: Fig. 11. Symptoms of manganese deficiency include green banded veins

Zinc

Symptoms of zinc deficiency are like those for iron deficiency (see above). Usually, first symptoms begin on youngest leaves. Tips of terminals may quit growing. Plants may be slightly stunted.

OTHER ABIOTIC STRESSES

Roses can be detrimentally affected by other factors besides nutrition issues. They are subjected to heat stress, transplant shock, cold temperatures, pesticide exposure, genetic issues, etc. Many roses are suited for hot environments. Some things like early freezes, genetic issues, etc. cannot be prevented. However, their effects on rose health can often be minimized.

ENVIRONMENTAL STRESSES (OTHER THAN NUTRITION)

Transplant Shock

Roses can be purchased as bare root stock, in containers, and dormant in packages (Fig. 12). Each type of roses has advantages and disadvantages. Bare root roses are easier to ship to consumers and are usually a quality #1 rose. They are usually less expensive than one in a container. However, bare root roses are more susceptible to transplant shock.

Since the roots are pruned to make the rose easier to ship, most of the feeder roots (those that can take up water) are pruned away. When a bare root rose is transplanted in its dormant state, the roots begin to grow even if environmental conditions are not conducive for shoot emergence. Container roses are likely to have more feeder roots and can uptake more water. However, container roses often have foliage and even blooms that increase water demand. The root system may not be sufficiently large to prevent the top from wilting. This leads to leaves yellowing, scorching and leaves dropping from the plant (Fig. 13). Leaf growth may also be impeded. Most roses grow out of transplant shock in during the first season. However, some roses may not grow as expected till the second year. Mulching to prevent water loss will decrease transplant shock. However, if temperatures are high, roots may not be able to supply sufficient water even if the soil is wet.

TOP, RIGHT: Fig. 12. Roses can be purchased bare root and in containers with actively growing root systems. Each type has advantages and disadvantages for transplant shock.

BOTTOM, RIGHT: Fig. 13. Symptoms of transplant shock include chlorosis, leaf scorching, and leaf drop. Photo credit: Kate Walz. https://garden.org/thread/view/66777/Transplanted-Knockout-Rose/

Heat Stress

Many roses can tolerate high temperatures encountered in the southern and southwestern U.S. However, some roses perform less well in hot conditions. Heat stress can lead to scorched leaves (Fig. 14A) and blossoms (Fig. 14B). Scorching is a natural way for the rose to control water loss via transpiration. Water is not loss via the stomata in scorched areas of the leaves. Scorched foliage can be tan to brown and may have a chlorotic border.

TOP, RIGHT: Fig. 14 A. Scorched areas may have a chlorotic border. B. Petals are often scorched as well. Petals have poorly developed vascular systems and insufficient water during periods of heat stress is common. Photo credit: https://www.treloarroses.com.au/Heat-Scorching-Roses

Another form of heat stress is called black leaf. Black leaf is poorly understood but occurs in many rose cultivars. Foliage becomes bronze when temperatures are high (Fig. 15). Black leaf may be due to a combination of heat, spraying pesticides during hot periods and possibly nutritional interactions. To date, black leaf has received little study by the scientific community although we receive inquiries concerning roses with black leaf every year.

MIDDLE, RIGHT: Fig. 15. Black leaf is a bronzing of foliage thought to be associated with high temperatures. Photo credit: Mike Bernoi, Velvet Rose Care.

Cold Stress

As with heat stress, many roses are tolerant of cold weather. However, all roses are susceptible to cold stress if they have not adequately hardened off before cold weather occurs (Fig.16). Affected tissues are necrotic and vertical splits are often observed. These splits are caused by expansion of water as it freezes in rose tissues. For grafted (budded) roses, holes should be dug sufficiently deep at transplanting to ensure the graft union is below ground. Mulch can be applied for more winter protection.

BOTTOM, RIGHT: Fig. 16. All exposed parts (stems and graft union) of a rose are susceptible to cold stress. Photo credit: Chris VanCleave.

Water stress

During periods of drought, roses can wilt due to lack of water available for translocation from the roots to the foliage (Fig. 17). During periods of excessive rainfall, plants may also wilt if they are located in areas of poor drainage. Poor drainage can be caused by planting in areas where water ponds, on slopes where water is constantly running during wet weather and in heavy soils (high clay content). If poor drainage is suspected, roses can be grown in the area in raised beds. In heavy soils, care should be taken to break up edges of the hole at transplanting. This is accomplished by scoring the sides of the hole with the digging spade. If the hole is not scored, the hole in clay soils may resemble an unfired clay pot due to soil compression while digging. Soil compression will not allow water to perk into the root system area when needed and perk out of the root system area when water is in excess.

Glyphosate Exposure

The herbicide glyphosate (Roundup®) is commonly used around rose beds to control broadleaf weeds and grasses. Roses are seldom killed by drift of glyphosate spray, however the plants can be seriously damaged. Although glyphosate does not volatize, superfine droplets of glyphosate spray may persist in air currents and land on green rose foliage, buds, blooms, etc. and subject roses to a nonlethal dose of the herbicide. Symptoms include distorted foliage (unusually small and thin), leaf chlorosis that can be as severe as loss of all green pigment, distorted blooms and flower buds, and shortened internodes which give stems a bunched or witch's broom affect (Fig. 18). If glyphosate is used in late fall, symptoms of glyphosate exposure may not be apparent till spring. Glyphosate exposure symptoms may also be confused with symptoms of rose rosette disease (Fig 19).

TOP, RIGHT: Fig. 17. Wilting of foliage is due to root problem. This problem can be due lack of water, excess water, and root rot. Photo credit: https://ask2.extension.org/questions/191563

MIDDLE, RIGHT: Fig. 18. Glyphosate exposure results in yellow to white foliage that is distorted. Stem internodes are shortened giving the plant a witch's broom appearance. Flowers are distorted.

BOTTOM, RIGHT: Fig. 19. Rosettes caused by infection by Rose Rosette Virus (Rose Rosette Disease) are sometimes confused with glyphosate damage. The two can be distinguished by RRD symptoms of hyperthorniness (a profusion of thorns or prickles), thicken stems and enhanced redness of strapped (long thin leaves). Rosette stems also extend above non-symptomatic foliage.

For more information concerning how to distinguish RRD from glyphosate damage, please refer to publication Early Detection of Rose Rosette Disease*. https://extension.tennessee.edu / publications/Documents/SP806.pdf*

Glyphosate is not tied up in organic matter, mulch and soilless mixes like it is in clay soils. Roots, that grow into rose bed mulch or grow from plants in containers that contain soilless mixes, can absorb glyphosate and develop symptoms consistent with foliar glyphosate exposure. Glyphosate is not labelled for use in pot-in-pot culture because soilless growth media are often used in this type of nursery production. Similar soilless mixes are used by rosarians for growing roses in large containers. Therefore, rosarians should limit their use of glyphosate and consider a contact herbicide such as glufosinate for post-emergent weed control.

GENETIC DISORDERS/MUTATIONS

Blind canes (stems)

Roses are grown for the beauty of their flowers not for their thorny stems. A blind cane is a stem that remains in vegetative growth and does not produce blooms (Fig. 20). These stems are usually pruned out of the bush. Blind canes are thought to be a genetic abnormality. However, they may also be caused by some nutritional disorders.

TOP, RIGHT: Fig. 20. Blind canes are stems that remain in the vegetative state and do not produce blooms.

Fasciation

This phenomenon is thought to be a genetic abnormality in roses. However, in some herbaceous crops, it can be caused by the bacterium *Rhodococcus fascians*. This bacterium has not been associated with fasciation in roses. Symptoms include a flattening of the stem, leaves and blooms (Fig. 21). Fasciation is not contagious and will not spread to other stems or rose bushes. Some people leave the fasciated stem in their garden as a curiosity. Other people cut it out due to it not being normal growth.

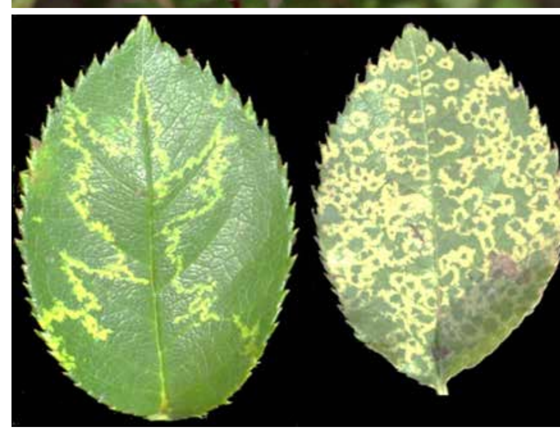
MIDDLE, RIGHT: Fig. 21. Flattening of stems and foliage is called fasciation. The cause is thought to be due to a genetic abnormality. Being a genetic abnormality, the condition is not contagious to other bushes in the garden.

Rose proliferation/double shoots

Vegetative shoots, leaves, and/or flower buds emerging from an open bloom is known as proliferation (Fig. 22). This is considered a genetic abnormality (mutation). Subsequent blooms on the same stem are unlikely to suffer from this mutation. Another genetic abnormality is double or twin shoots (Fig. 23). In some ways, this phenomenon is similar to identical twins in that the flower meristem splits into two identical parts and both parts develop into mature flowers. Like proliferation, other flowers arising on the same stem are not likely to have the same issue.

BOTTOM, RIGHT: Fig. 22. Rose proliferation is a genetic mutation of leaves or flower buds developing in the center of rose blooms. The condition is not contagious. Photo credit: Paul Zimmerman Rose Gardening. https://www.facebook.com/photo?fbid=10156722769390808&set=pcb.101581573 6469197

TOP, RIGHT: Fig. 23. Flower doubling is due to a spitting of the flower meristem before the meristem begins to develop into a rose bud. This phenomenon results in two identical flower buds. The bloom on the left is a normal bud of 'Black Baccara' (photo credit: https://www.kalliergeia.comenblack-baccara-hybrid-tea-rose-the-black-roses). In the two photos on the right (photo credit: Rita Van Lenten) the identical buds are a result of flowering doubling.



Variegation

A genetic mutation that causes pigment patterns in leaves or petals is known as variegation. Sometimes, variegation, especially in petals, can be induce via breeding. Variegation can be very desirable and stable from one vegetatively propagated generation to the next (Fig. 24). Variegated foliage, though attractive, often leads to slightly smaller plants and slightly fewer and smaller flowers. Sometimes, if the variegation is extensive, the loss of chlorophyll may be detrimental to plant vigor due to the plant's inability to fix sugars via photosynthesis. Extensively variegation can also increase sensitivity to sunlight and result in scorching of leaves. Caution should be taken to insure that the "variegation pattern" is a genetic mutation and not symptoms of a virus infection. Variegation due to viruses usually consists of vein banding, line patterns, and ringspots (Fig. 25). If you are suspicious of the cause of the variegation, a sample of the 'variegated' foliage should sent to your state's diagnostic lab via your local county agent's office to ensure it is not a virus infection.

MIDDLE, RIGHT: Fig. 24. The rose cultivar 'Sentimental' displays variegation in its petals. The variegation pattern is different in every bloom and no two blooms on the same bush are identical in appearance. Photo credit: Michigan Blub Company.

BOTTOM, RIGHT: Fig. 25. Not all "variegation patterns" are due to genetic mutations. Vein banding, ring spots, mosaics, mottles, and line patterns, though stable via vegetative propagation, is often due to a virus infection. The plant in the lower half of the figure was propagated via cuttings by its owner and distributed to the owner's friends as an unusual, variegated plant. Fortunately, the rose distribution was halted when the source of the variegation was diagnosed as a virus infection.

CONCLUSIONS

There are many environmental stresses ranging from nutrient deficiencies to glyphosate exposure. The first step for avoidance of nutrient deficiencies and toxicities is having an annual soil test for rose beds and containers. Phosphorus toxicity is often associated with rose beds ("tired beds") that no longer support vigorous roses. If roses are grown in clay soils, the sides of holes should be scored with a shovel to ensure that water can perk in and out of area where roots are growing and to encourage root growth outside of the hole. If possible, use a contact herbicide such as glufosinate instead of systemic glyphosate for post-emergent weed control. Genetic disorders such as variegation can be desirable, but extensive variegation in foliage can be detrimental to vigorous plant growth. Care should be taken to ensure that the variegation is foliage is not due to virus infection.

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