X. NONCONTAGIOUS DISORDERS

Adverse growing conditions can cause symptoms that mimic contagious diseases but are not caused by a pathogen. For example, leaf spotting from a misapplied spray or root damage resulting from high levels of soluble salts are common symptoms mistaken for diseases caused by a pathogen. A cultural history is often the key to interpreting symptoms of plant damage. In a few cases, it will be difficult to make an accurate determination without a formal laboratory diagnosis that includes an analysis of the soil or the foliage.

Spray Injury

Spray applications of pesticides, growth regulators, and fertilizers can cause plant injury if applied to sensitive plants, at excessive rates, or under the wrong conditions. Some plant responses to common treatments are actually *not* problematic, such as the yellowing of geranium leaves following Cycocel (a growth regulator) application. In this case, the injury is temporary and not harmful to the crop. Certain cultivars may exhibit this response, while others will be unaffected.

Plant Signs and Symptoms

Plants will show brown spotting, a faint yellowish mottling, leaf edge burn or yellowing, or bronzing of leaf undersides. Spray damage can appear within hours of treatment or a few days later. Petals, buds, and young growth are usually most susceptible to injury and may become twisted or distorted when they fully expand.

Monitoring

Inspect crops visually, noting locations of symptoms on plants and distribution of injury throughout each crop. Spray injury

will usually appear quickly, with all plants showing symptoms simultaneously. It differs from contagious disease development, where symptoms develop over time and only a limited number of plants are infected initially.

Management

If you suspect spray injury,

- review the materials and application methods, rates, timing, and frequency with the applicator;
- monitor environmental conditions such as high humidity, wet foliage, or temperatures above 85°F—all of which can lead to the development of spray injury;
- be sure that plants are not stressed. Plants under stress are generally more prone to injury than healthy plants.

Excess Soluble Salts

Soluble salts can build up in the growing media. You will find this particularly in crops receiving regular fertilization, where the mineral content of the water is high and there is little or no leaching. High levels of soluble salts reduce water uptake and are toxic to root tissue.

Plant Signs and Symptoms

Root tips desiccate, collapse, and turn brown, reducing plant water uptake. Results can be wilting, marginal chlorosis (yellowing) or necrosis (tissue death), stunting, and invasion by pathogens.

Monitoring

Look for this injury first in areas where pots or flats dry out, such as at the ends or sides of benches. Knock several plants out of their pots or flats to see whether plant roots are healthy and white. Discolored and collapsed root tips may be the result of root rot caused by a pathogen such as *Pythium* or root desiccation caused by high levels of soluble salts. Monitor soluble salts regularly.

Management

If high soluble salts are detected in the growing medium

- leach with dilute fertilizer solution or clear water;

- adjust the crop's fertilization program and watering practices.

Problems with pH

The three most frequently encountered problems related to pH in bedding plants are iron/manganese toxicity (which occurs when the pH value is lower than 5.8); iron, manganese, copper or zinc toxicity (which occur when the pH value is higher than 6.2); and boron deficiency, caused by low levels of micronutrient amendments in the substrate or soluble fertilizer.

Plant Signs and Symptoms

Low pH. When grown at an excessively low pH, French dwarf double or Signet-type marigolds exhibit stunting and purplish flecking on leaves. This is caused by iron-manganese toxicity. Zonal geraniums are also sensitive to very low pH. For example, 'Aurora' is a cultivar that shows brown flecking, necrotic margins, and chlorosis (yellowing) on the lower leaves, which is again a response to excessive uptake of iron or manganese. Many other zonal geranium cultivars may show this same response to excess iron or manganese.

High pH. Symptoms caused by lack of micronutrients or high pH (which makes micronutrients unavailable) are listed in table 16.

Monitoring

Check pH levels regularly, especially in sensitive crops, to make sure they are within the acceptable range. Micronutrient levels are monitored by plant leaf analysis.

Management

- Raise the pH to 5.8–6.2.
- Change the fertilizer program to products that raise pH, or treat with lime (1 teaspoon dolomitic lime per 6-inch pot) to improve crop health.
- Apply 1 to 2 pounds potassium carbonate or potassium bicarbonate to 100 gallons of water; mix, and let sit overnight. Water with the supernatant the next day for a

rapid, short-term increase in pH. Or add 1 pound hydrated lime to 100 gallons of water, mix, and let sit overnight. Water with the supernatant the next day for a rapid, short-term increase in pH.

Nutrient Toxicities and Deficiencies

Inadequate or excessive levels of plant nutrients can cause a variety of symptoms that affect bedding plant growth and appearance. These problems are caused by improper fertilization, irrigation water with incorrect pH or alkalinity, or incorrect soil pH and soluble salts.

Plant Signs and Symptoms

The following three tables list symptoms associated with inadequate or excessive levels of nutrients. The first lists macronutrient deficiencies in bedding plants; the second lists micronutrient deficiencies in bedding plants; and the third lists toxicity symptoms caused by excessive levels of nutrients.

Monitoring

Look for these problems during routine scouting. Regular measurements of pH and salts will signal the onset of soil conditions that could favor development of these toxicities and deficiencies.

Table 16. Macronutrient deficiency symptoms for several crops

	Nutrient[1]					
	N	**P**	**K**	**Ca**	**Mg**	**S**
SYMPTOM						
Whole Plant						
Stunted	BMP G[2]	BM PG	BM PG			
Defoliated	G		G			
Off color		P				
Deep green						
Dull green		G				
Pale green						G
Branching, compact growth, short internodes			M			
Leaves						
Young (upper) leaves						
Chlorosis						
Whole leaf	BG					
Interveinal						
Tips				G		
Necrosis (dead areas)				G		
Tips						
Margins						
Vein tops						
Reddeing/ bronzing						
Whole leaf		BG				
Cupping/curling						
Downcupping						
Upcupping				G		
Older (lower) leaves						
Chlorosis						
Whole leaf	BMP	PG	BG			
Margins						G
Interveinal					PG	
Necrosis (dead areas)	P	P				
Whole leaf						
Margins			PB			
Tips			G	BM		
			G			
Reddening/ bronzing	G	G				
Whole leaf	BMG	BMG				
Margins						
Cupping/curling						
Downcupping			M			

[1]N = nitrogen; P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium; S = sulfur [2]B = begonia; M = marigold; P = petunia; G = general crops. Used with permission from *Water and Nutrient Management for Greenhouses,* published by NRAES-56, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701; 607-255-7654.

Table 17. Micronutrient deficiency symptoms for several crops

	Nutrient[1]					
	B	**Mn**	**Cu**	**Fe**	**Zn**	**Mo**
SYMPTOM						
Whole Plant						
Stunted						
Defoliated						
Off color						
Deep green	G[2]					
Dull green						
Pale green						
Branching, compact growth, short internodes	P				G	
Leaves						
Young (upper) leaves						
Chlorosis						
Whole leaf	PG			G		
Interveinal		PG	G	PG	G	
Tips				G		
Necrosis (dead areas)						
Tips						
Margins	PG					
Vein tops						
Cupping/curling						
Downcupping	G					
Upcupping						
Older (lower) leaves						
Chlorosis						
Whole leaf	P					
Margins						
Interveinal						
Necrosis (dead areas)						
Whole leaf						
Margins/Tips						
Reddening/ bronzing						
Cupping/ curling						

[1]B = boron; Mn = manganese; Cu = copper; Fe = iron; Zn = zinc; Mo = molybdenum; [2]G = general crops; P = petunia**;** Used with permission from *Water and Nutrient Management for Greenhouses,* published by NRAES-56, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701; 607-255-7654.

Table 18. Nutrient toxicity symptoms

Excess Nutrient	Salt Injury[1]	Nutrient Deficiency[2]	Chlorosis	Necrosis	Other
N[3]	yes				
NH_4			Lower leaf margins		Orange-brown root tips
P		Fe, Zn, Cu, Mn			
K		N, Ca, Mg			
Ca		K, Mg, B			
Mg		Ca			
S					
B				Lower leaf margins	
Mn		Fe		Tips or across leaf	
Fe		Mn	Upper leaves	Small spots	
Cu		Mn			
Zn					
Mo					
Other				Leaf margins	

[1]Injury to root system resulting in wilting and leaf curl

[2]Caused by interaction with excess nutrient

[3]N = nitrogen; NH_4 = ammonia; P = phosphorus; K = potassium; Ca = calcium; Mg = magnesium; S = sulfur; B = boron; Mn = manganese; Fe = iron; Cu = copper; Zn = zinc; Mo = molybdenum

Used with permission from *Water and Nutrient Management for Greenhouses,* published by NRAES-56, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701; 607-255-7654.

Injury from Air Pollutants

In the cool temperatures at the beginning of the bedding plant season, unvented space heaters frequently injure plants. Smokestacks that are not tall enough may also cause phytotoxic fumes to be pulled back into a greenhouse through the vents. The resulting sulfur dioxide (if the fuel contains sulfur) may cause bleached or dead areas between the leaf veins of sensitive bedding plants.

Ethylene, a gas that can result from incomplete combustion of fossil fuels, is sometimes formed in greenhouses when burners have insufficient oxygen. Ethylene can cause various plant symptoms, including distortion of terminal growth, inhibition of the apical meristem, flower drop, and leaf chlorosis. Tomatoes are particularly sensitive and have been used as indicator plants. Ivy geraniums will show leaf chlorosis (yellowing).