used for turf and soil protection. We examined more than 800 herbarium specimens in 93 grass genera: Agrostis, Bromus, Cinna, Elymus, Festuca, Lolium, Melica, Poa, Sitanion and Stripa. Many of these endophyte-containing species were native to the U.S., but much work is needed on the role of endophytes in these and many other grasses.

This article was developed by editing the following papers: "Importance of Acremonium Endophytes in Turfgrass Breeding and Management" by C.R. Funk and J.P. Breen of Rutgers University and R.H. White of Texas A&M University; "Endophyte Content of Cultivars and Selections in the 1990 National Perennial Ryegrass Test" by Suichang Sun, Nancy Januszka, Kelly Hollowood, Maribeth Wheeler, Carolyn Garvey and Jennifer M. Johnson-Cicalese, senior lab technician and lab assistant at Rutgers University and lab assistants and research associate at the University of Rhode Island.

TALL FESCUE SEED CONTAINING VIABLE ENDOPHYTE AS RELATED TO STORAGE ENVIRONMENT AND DURATION OF STORAGE

STORAGE ENVIRONMENT	TEMP. F°	MONTHS IN STORAGE 3	7	11	15	19	27
FREEZER	-4	100	100	100	100	90	90
REFRIGERATOR	43	100	90	85	90	95	90
SEED STORAGE RM.	50	90	100	80	75	45	25
ROOM TEMP.	70	95	55	0	0	0	0
SEED WAREHOUSE	70-95	95	60	0	0	0	0

M.C. JOHNSON 1984

—The author is director of research at Lofts Seed Inc. and an adjunct professor at Rutgers University.

Monitoring chlorine damage to plants

Even small emissions of chlorides can cause severe damage to plants near the leak, as observed in New York and Nevada.

by Dr. Robert Ll. Morris and Karen Lawson-Dyka, University of Nevada

■ Landscape managers should pay particular attention to any plant damage that may be caused by chlorine gas or hydrogen chloride. Such problems have been associated with the gases escaping from industrial sources during the manufacturing process or from accidental leaks.

(Chlorine and hydrogen chloride are used to produce pesticides and synthetic materials such as plastics and disinfectants. Emissions of chlorine have occurred around potash works, from pickling baths of hot-dip galvanizing plants, and in the combustion of PVC-containing wastes. Accidental emissions have occurred near swimming pools, sanitation plants and factories.)

Twice in Yonkers, N.Y., emissions have damaged 30 species of plants, including tree-of-heaven, apple, cherry, maple, basswood, dogwood, elm, ash, sweetgum, hemlock, oak and white pine. A more recent accident occurred in southern Nevada (see related story).

Chlorides have a herbicide-like effect on plants. Even small emissions can cause severe damage to plants near the leak. Plant damage is generally measured at about 4-1/2 feet above the ground, or at the upper limit of vegetation.

Table 1

TYPES OF DAMAGE FROM CHLORINE

Broadleaf plants

- leaf and flower drop
- bronzing
- chlorosis
- marginal and interveinal necrosis
- mottling and chlorotic flecking
- bleached tissue
- orange-brown necrosis
- dieback
- stem and leaf wilting
- blazing on leaf underside (not noted in Nevada, but reported in literature)

Conifers

- needle tip burn
- candle distortion (not in literature, but found in multiple Nevada locations)
- reddish-brown necrosis
- dieback

Grasses (and other monocots)

- leaf tip burn
- marginal leaf burn
- chlorosis
- twisted blades (not in literature, but found in multiple Nevada locations)

Source: The authors

Plant damage can be divided into four non-lethal categories:

(1) rapid leaf drop; **(2)** tissue chlorosis or discoloration; **(3)** tissue distortion and tip burn; and **(4)** marginal and interveinal necrosis.

The degree of plant damage depends on the amount of chlorine in the air, its duration of exposure, susceptibility of the plant to damage, and environmental conditions such as moisture content and temperature.

Lower concentrations of chlorine in the atmosphere will do more visible damage when humidity is high.

Under high humidity (more than 80 percent) or when fog or dew is present, chlorine combines with water vapor to form a hydrochloric acid aerosol mist on plant surfaces. Under these conditions, droplets may form on leaf surfaces, causing necrotic spots or burns to form.

Under low humidity, the chlorine gas forms an anhydrous hydrogen chloride which may cause less visual damage but has been speculated to cause more severe damage because of the dehydrating action on exposed tissue.

Acute damage happens so rapidly that chlorine is not assimilated by the plant and cannot be detected easily in tissue samples.

Table 2

SEVERITY OF DAMAGE TO PLANTS IN SOUTHERN NEVADA

NONE	SLIGHT	MODERATE	SEVERE
asparagus fern	Algerian ivy	agave dianthus	apricot
barrel cactus	ash	heavenly bamboo	bird of paradise
cholla cactus	canna	honeysuckle	chinaberry
dusty miller	bush morn. glory	stone pine	Chinese/Sib. elm
euonymus	English ivy	Jap. black pine	lilac
hesperaloe	fortnight lily	lavender	marigolds
ice plant	photinia	magnolia	nectarine
juniper	iris	Mexican primrose	olive
myrtle	pampasgrass	mulberry	peach
palms	pittosporum	mums	plum
pyracantha	salvia	oleander	poplars
rosemary	snapdragon	pansy	rose
santolina	verbena	pomegranate	
turfgrasses	Italian cypress	Idaho locust	
wisteria	heavenly bamboo	silk tree	
yucca	arborvitae	privet	
Texas ranger	almond		
athel	chrysanthemum		
star jasmine	Indian hawthorn		

Source: The authors

The Nevada burn

■ Early in the morning of May 6, 1991, a large blue-green cloud was released from a broken two-inch line that led to a 150-ton storage tank of liquid chlorine. An industrial plant in southern Nevada accidentally released 60 tons of chlorine that rapidly vaporized and caused the evacuation of 10,000 residents in a 20-square mile area. Nine people were hospitalized. In the affected area, landscape plants bathed in an unknown concentration of chlorine gas for several hours.

A team of commercial horticulture volunteers surveyed landscape plant damage in a neighborhood within 1/2 mile of the chlorine leak one week after the accident. Recorded plant damage is shown in Table 1. Table 2 lists the plants that were found to have probable chlorine emission damage.

Within 24 hours after emission, partial to total leaf drop occurred on elm, cottonwood, chinaberry, all stone fruits, some pome fruits, rose, olive, mulberry, pomegranate, Texas privet and Indian hawthorne.

Flowers were not affected and were more tolerant of exposure to chlorine with one exception: leaf and flower drop on Indian hawthorne. Chlorosis and necrosis occurred three to five days after emission. New growth began to cover damaged tissue, and refoliation occurrred in seven to 10 days.

All pines suffered some sort of damage, ranging from twisting and dieback of new growth (candles) to needle tip burn and needle drop.

Turfgrasses (tall fescue, bluegrass and bermuda) all tolerated the exposure with no visible damage. In some cases, chlorine damage was difficult to separate from previous winter damage.

—Dr. Morris, Ms. Lawson-Dyka

Treat now for pythium rots

This is the time of year to make sure pythium rots don't take away valuable turf areas.

■ Although this disease is most frequently associated with established bentgrass/annual bluegrass putting greens, it can also be a serious problem on highly managed home lawns and newly-seeded areas. It is particularly severe on ryegrasses, bentgrasses and bluegrasses.

To minimize turfgrass losses from pythium root rot (PRR), Dr.Eric Nelson of Cornell University says, manage to reduce plant stress or eliminate prolonged wet periods.

Early symptoms of PRR may be visible in the early spring immediately after snow melts, but are most common in the late spring. Symptoms may be evident any time during the growing season, and may continue into late autumn.

Symptoms:

- small diffuse yellow or reddish brown patches about two to three inches in diameter, often resembling early stages of pink snow mold;
- plants slow to come out of winter dormancy;
- less vigorous growth;