e-GRO Edible Alert

W. Garrett Owen
wgowen@uky.edu

Volume 6 Number 13 October 2021

Potassium Deficiency of Greenhouse Cucumbers

Potassium deficiency of greenhouse cucumbers may be initially observed as chlorosis (yellowing) of the older lower leaf margins. As symptoms progress, interveinal chlorosis and firing (necrosis) of the leaf margin and interveinal regions will develop while the leaf midrib and veins remain green.

Managing pH and mineral nutrient concentration in hydroponic solutions is important for maintaining healthy crops and maximizing yield. Routine sampling and analysis of the nutrient solution should be performed to check pH, electrical conductivity, alkalinity, and mineral nutrient concentrations. In addition, leaf tissue sampling and analysis should be performed to determine mineral nutrient concentrations and if any adjustments to the nutrient solution is warranted. When routine sampling and analyses are not performed, nutrient disorders may develop due to pH drift or an imbalance of nutrient uptake relationships.

Nutrient uptake relationships first start with understanding the chemical properties of each mineral nutrient. Though these will not be discussed independently, in general, when fertilizer salts are dissolved in solution, nutrients are essentially available in their ionic form. Each ion is associated with a positive charge (cation) or negative charge (anion), and the number of electrons (valence). Some pairs of nutrients with similar ionic charges are known to have a competitive (antagonistic) or complimentary (synergistic) relationship. This relationship determines how nutrients are taken up the plant and the concentration of the nutrients found in leaf tissue. A perfect example is the potassium (K) – calcium (Ca) – magnesium (Mg) relationship. Potassium has a positive charge (K^+) and interacts with other cationic nutrients such as calcium (Ca^{2+}) and magnesium (Mg^{2+}). The interaction among these nutrients is antagonistic which affects their nutrient uptake in the root-zone and concentration of each in plant tissue. This is important because K can greatly inhibit Ca and Mg uptake. However, Ca and Mg can also inhibit K uptake, but the depressing effect varies between Ca:K and Mg:K. Additionally, excessive levels of sodium (Na^+) can also affect nutrient uptake of K, Ca, and Mg.] In general, the ratio of K:Ca:Mg should be 4:2:1. Nonetheless, when an antagonistic relationship occurs, nutrient disorders can develop. This e-GRO Alert will focus on K deficiency symptomology of greenhouse-grown English and mini cucumbers (*Cucumis sativus*) under controlled research conditions caused by excessive Ca and Mg concentrations in the root-zone and leaf tissue.

Various stages of K deficiency symptoms were observed among English and mini cucumber high-wire crops. Initial K deficiency symptoms of cucumber leaves included marginal leaf chlorosis (yellowing) of the older lower leaf margins (Fig. 1). As symptoms progressed, interveinal chlorosis (Fig. 2) developed starting from the leaf margin and intensifying into the leaf towards the midrib (Fig. 3). Leaf firing or necrotic spots (dead tissue) developed along the leaf margin (Fig. 4). Overtime, firing developed among interveinal regions (Fig. 5) giving a speckled or cheetah-like appearance (Fig. 6). These necrotic regions may fall from the leaf, littering the greenhouse floor and leaving behind a windowpane-like appearance. While interveinal regions of the leaves are affected, the leaf midrib and veins remained green (Fig. 6). Figure 7 demonstrates the progression of K deficiency that manifested overtime. It is worth noting the incidence and symptom severity varied between long English and mini cucumbers and with fruit load. Plants with higher fruit loads exhibited intensified symptoms than those with lighter loads because of source-sink

Figure 1. In cucumber (*Cucumis sativus*), initial potassium deficiency symptoms occur on the older lower leaf margins as marginal leaf chlorosis (yellowing). Photo by W. Garrett Owen.

Figure 2. Moderate potassium deficiency symptoms of cucumber (*Cucumis sativus*) can be observed as interveinal chlorosis (yellowing). Photo by W. Garrett Owen.

Figure 3. Potassium deficiency of cucumber (*Cucumis sativus*) can intensify and be observed as interveinal chlorosis (yellowing) starting from the leaf margin and progressing into the leaf towards the midrib. Photo by W. Garrett Owen.

relationships due in part to lower leaf removal.

The described symptoms were the result of the antagonistic relationship between Ca and Mg on K uptake. Excess Ca and Mg were supplied in the fertilizer solution and from the irrigation water which impeded the uptake of K by the plant. These symptoms were confirmed with leaf tissue nutrient analysis and provided in Table 1. From the tissue report, the ratio of K:Ca:Mg is 2:5:2. Calcium is clearly being supplied in excess and affected the uptake of K. To prevent nutrient disorders, growers should routinely sample irrigation water, nutrient solution, and leaf tissue to evaluate the fertility regimen and nutrient concentrations. To learn how to sample irrigation water, interpret water quality results, and sample leaf tissue, refer to:

- e-GRO Alert 10.09: Sampling Irrigation Water for Routine Lab Analysis
- e-GRO Alert 10.11: Interpreting Water Quality Analysis Reports
- e-GRO Alert 9.06: Target Leaf Tissue Sampling for Precise Nutrient Diagnosis

To correct K deficiency, growers may consider one or combination of the following:

1. Adjust the nutrient solution via reducing Ca and Mg concentrations and increasing K concentrations by:

Check for Antagonistic Effects

A. Increase potassium nitrate (KNO_3) concentration;

B. Add potassium sulfate (K_2SO_4); or

C. If sodium chloride (NaCl) is not present in the irrigation water or nutrient solution, apply potassium chloride (KCl).

Figure 4. Leaf firing or necrotic spots (dead tissue) can develop along the leaf margin of older cucumber (*Cucumis sativus*) leaves deficient of potassium. Photo by W. Garrett Owen.

Figure 5. Overtime, leaf firing or necrotic spots (dead tissue) can develop among interveinal regions of older cucumber (*Cucumis sativus*) leaves giving a speckled or cheetah-like appearance. Photo by W. Garrett Owen.

Figure 6. Cucumber (*Cucumis sativus*) leaves exhibiting advanced potassium deficiency symptoms of marginal and interveinal chlorosis (yellowing) and firing (necrotic tissue), while the leaf midrib and veins remain green. Photo by W. Garrett Owen.

2. Spray foliar applications of 2% potassium sulfate (K_2SO_4)

To learn more about the role of K and creating a nutrient program for greenhouse cucumbers refer to:

- e-GRO Edible Alert 4.04: K is for Cucumbers

Overall, performing routine water, nutrient, and leaf tissue analysis will help keep your fertility program in check, minimize nutrient disorders, and maximize plant health and yield.

Literature Cited

Bryson, G.M. and H.A. Mills. 2014. Plant analysis handbook IV. Micro Macro Publishing, Athens, GA.

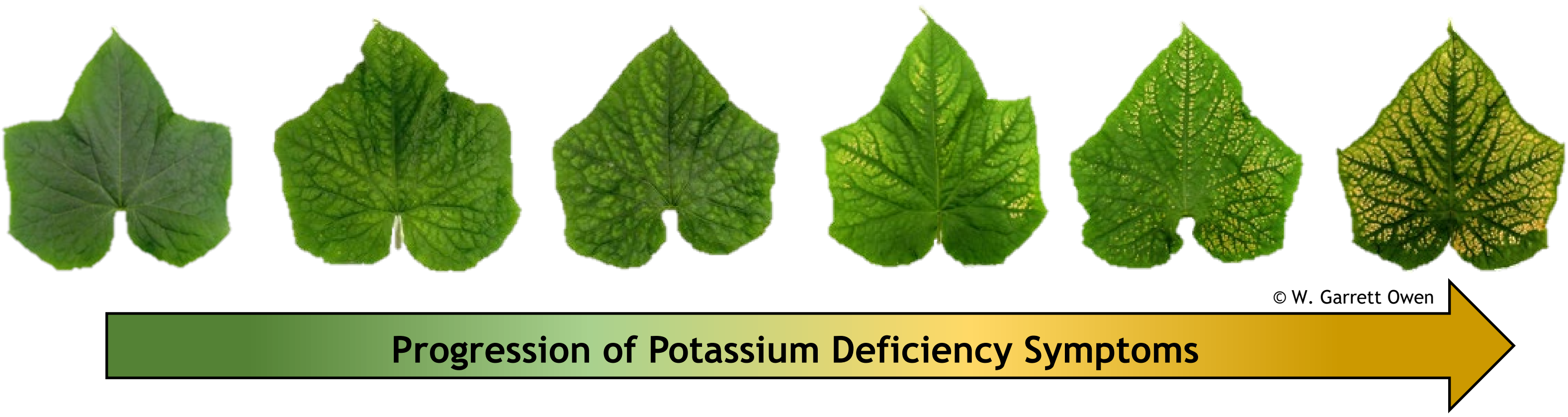

Figure 7. Depiction of potassium deficiency in greenhouse cucumber (*Cucumis sativus*) progressing from initial to advanced incidence. Figure by W. Garrett Owen.

Table 1. Leaf tissue nutrient value sufficiency range of greenhouse cucumber (Cucumis sativus) and plants grown under controlled potassium deficiency conditions. Values represent an average of eight fruiting plants.

Element		Recommended Range [1]	Potassium-deficient Cucumbers
Nitrogen (N)	(%)	4.30 - 6.00	4.67
Phosphorus (P)		0.30 - 1.00	0.82
Potassium (K)		3.10 - 5.50	2.76
Calcium (Ca)		2.40 - 4.00	7.05
Magnesium (Mg)		0.35 - 1.00	2.17
Sulfur (S)		0.32 - 0.70	1.04
Sodium (Na)		NR [2]	0.03
Chloride (Cl)		NR	0.04
Iron (Fe)	(ppm)	50 - 500	90
Manganese (Mn)		50 - 500	234
Zinc (Zn)		25 - 200	59
Copper (Cu)		8 - 10	9
Boron (B)		30 - 100	78
Molybdenum (Mo)		0.8 - 5.0	3
Aluminum (Al)		NR	9

[1] Bryson and Mills (2014); [2] NR = not reported.

e-GRO Alert

www.e-gro.org

CONTRIBUTORS

Dr. Nora Catlin
Floriculture Specialist
Cornell Cooperative Extension
Suffolk County
nora.catlin@cornell.edu

Dr. Chris Currey
Assistant Professor of Floriculture
Iowa State University
ccurrey@iastate.edu

Dr. Ryan Dickson
Greenhouse Horticulture and
Controlled-Environment Agriculture
University of Arkansas
ryand@uark.edu

Thomas Ford
Commercial Horticulture Educator
Penn State Extension
tgf2@psu.edu

Dan Gilrein
Entomology Specialist
Cornell Cooperative Extension
Suffolk County
dog1@cornell.edu

Dr. Joyce Latimer
Floriculture Extension & Research
Virginia Tech
jlatime@vt.edu

Heidi Lindberg
Floriculture Extension Educator
Michigan State University
wolleage@anr.msu.edu

Dr. Roberto Lopez
Floriculture Extension & Research
Michigan State University
rglopez@msu.edu

Dr. Neil Mattson
Greenhouse Research & Extension
Cornell University
neil.mattson@cornell.edu

Dr. W. Garrett Owen
Greenhouse Extension & Research
University of Kentucky
wgowen@uky.edu

Dr. Rosa E. Raudales
Greenhouse Extension Specialist
University of Connecticut
rosa.raudales@uconn.edu

Dr. Beth Scheckelhoff
Extension Educator - Greenhouse Systems
The Ohio State University
scheckelhoff.11@osu.edu

Dr. Ariana Torres-Bravo
Horticulture/ Ag. Economics
Purdue University
torres2@purdue.edu

Dr. Brian Whipker
Floriculture Extension & Research
NC State University
bwhipker@ncsu.edu

Dr. Jean Williams-Woodward
Ornamental Extension Plant Pathologist
University of Georgia
jwoodwar@uga.edu

Cooperating Universities

Cornell CALS — College of Agriculture and Life Sciences
Cornell Cooperative Extension Suffolk County
Iowa State University
University of Kentucky
PennState Extension
Virginia Tech
Michigan State University
UCONN
College of Agricultural & Environmental Sciences, University of Georgia
Purdue University
NC State University
The Ohio State University
UofA Division of Agriculture Research & Extension, University of Arkansas System

In cooperation with our local and state greenhouse organizations

Maumee Valley Growers — Choose the Very Best.
Metro Detroit Flower Growers Association
NC Flower Power
Western Michigan Greenhouse Association
Connecticut Greenhouse Growers Association
Indiana Flower Growers Association
LIFGA
Michigan Greenhouse Growers Council
NYSFI — New York State Flower Industries, Inc.
Virginia Flower Growers Association — Since 1954