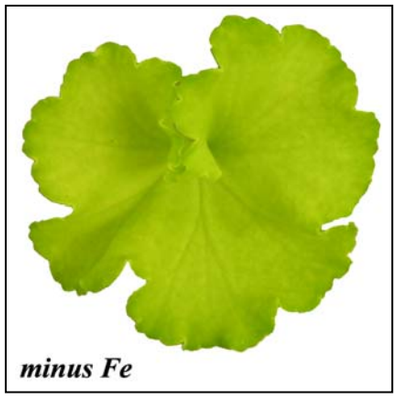


minus Fe

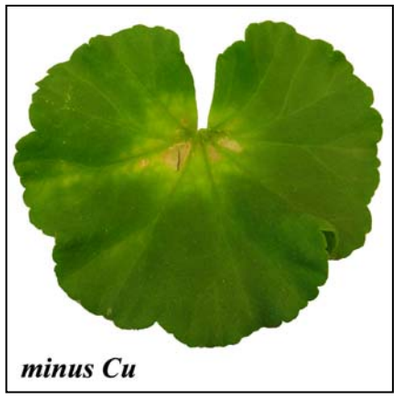
Generally, young leaves with an **IRON DEFICIENCY,** develop interveinal chlorosis, from the base, but in some species from the tip. Over time, interveinal chlorosis intensifies and the pattern becomes less interveinal. Even the stems appear chlorotic. At this point, the chlorotic symptoms are irreversible even if correctional measures are taken. Eventually, yellow gives way to white. The bioavailability of Fe is pH dependent; the lower the pH, the higher the solubility and hence the availability of iron to plants.

minus Mn

The young and recently matured leaves develop chlorosis followed by stippling of necrosis on recently matured leaves. Drastic reduction of shoot and root growth is common. Flowering is strongly inhibited. Environmental factors such as sunny summer months, greenhouses built close to traffic areas and ozonated water used in irrigation / fertigation may contribute to **MANGANESE DEFICIENCY**.

minus Zn

Young and recently matured leaves develop puckering, veinal chlorosis, and necrosis. Some plants may develop purple pigmentation. Shoot and root growth is reduced. A high level of P in the substrate induces **ZINC DEFICIENCY**. Zinc availability is reduced by high pH and bicarbonates (HCO_3^-).



minus Cu

Initially, in a plant that has **COPPER DEFICIENCY**, the young and maturing leaves appear stunted. In some species a tinge of bluish-green appears, especially over the veins. This is followed by impaired flower development that includes reduced size, premature abscission, or abortion. Sudden death of tissue, with symptoms similar to localized tissue dehydration, develops on recently mature leaves as a result of poor xylem tissue development. Chlorosis is generally not a distinguishing feature. Substrate with high pH or alkaline water may contribute to Cu deficiency. Symptoms appear initially at the base of the leaf and spread toward the margins.

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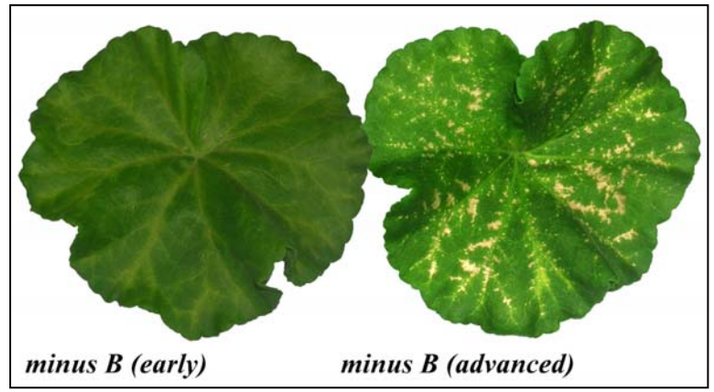
NUTRIENT DEFICIENCY SYMPTOMS OF GERANIUM

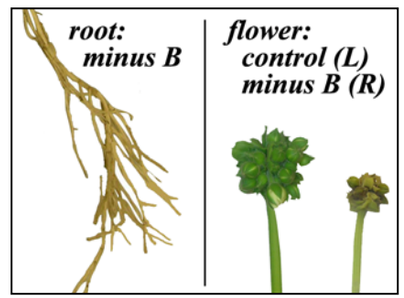
Dharma Pitchay, Jonathan Frantz, James Locke, Charles Krause#

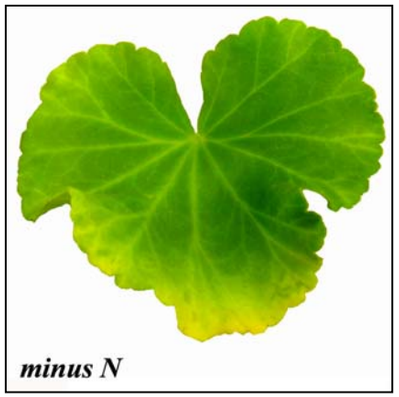
This guide is designed to assist growers in diagnosing nutrient deficiencies during geranium production. For more information, contact your state extension office or the organizations listed in this guide.



minus B (early) *minus B (advanced)*

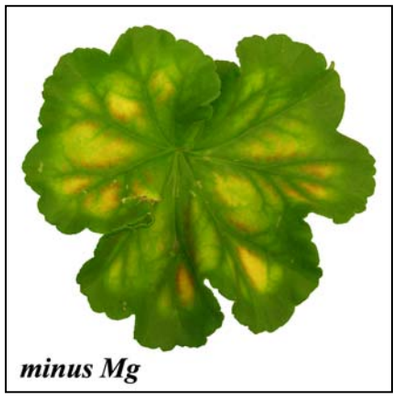
BORON DEFICIENCY disorders develop on the shoot and root meristem, and on young leaves. The symptoms develop on the roots 3 to 4 days earlier than the shoot. Overall, the roots are thick and short while primary roots develop thick swollen root tips with numerous short secondary roots developing close to the tip giving a “witch’s broom” symptom. Meanwhile, foliage becomes darker and glossy. Young and recently matured leaves become thick, leathery and brittle with severe distortions. Loss of apical dominance is a common symptom in the root and shoots. At this point, it is too late to take any correctional measures.





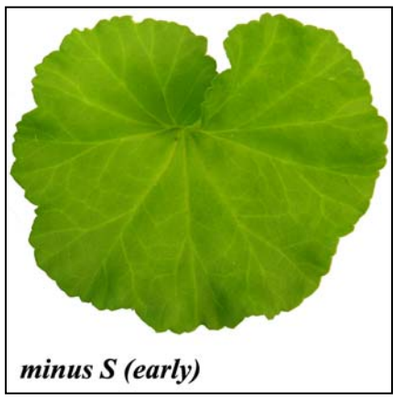
minus N

NITROGEN DEFICIENCY slows down the growth and development of plants. The plants appear stunted with light green lower leaves, while the upper leaves remain green. With prolonged N deficiency, yellowing (chlorosis) of older or lower leaves occurs. This is followed by leaf tip death and leaf margins developing a brown discoloration (necrosis). In some instances the leaves fall off. The plant stems become woody.



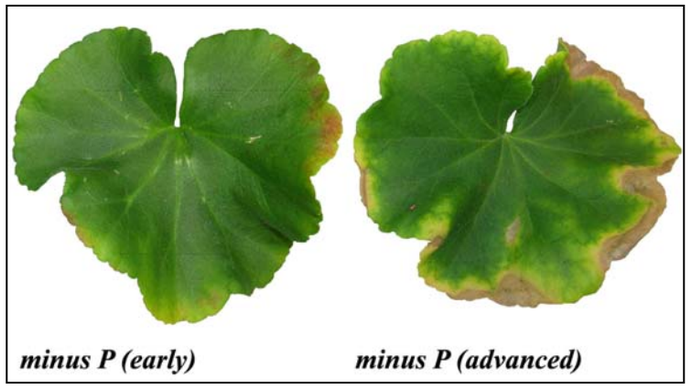
minus Mg

Normally, **MAGNESIUM DEFICIENCY** symptoms appear in lower, older leaves with chlorosis of greenish yellow to yellowish green developing along the leaf margins and tips, which progresses inward between the leaf veins. As the deficiency prolongs, necrosis develops between the veins and the leaves curl downwards. Eventually, leaf and plant death may occur if the magnesium deficiency continues.



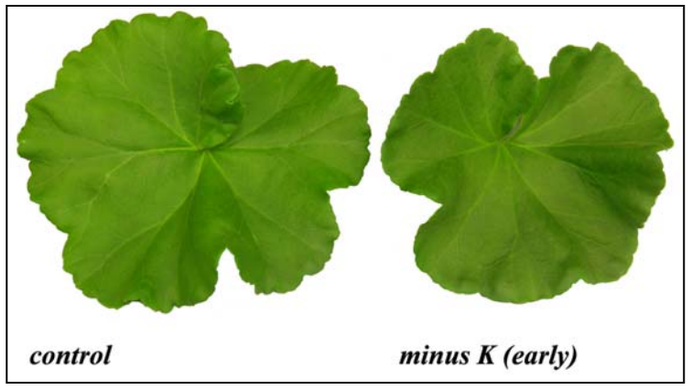
minus S (early)

Initially, uniform chlorosis of light greenish yellow pigmentation develops anywhere between the young and mature leaves, but rarely on lower, older leaves. As the symptoms of **SULFUR DEFICIENCY** advance, uniform chlorosis spreads to the rest of the leaf area.



minus P (early) *minus P (advanced)*

Initially, plants appear darker green with reduced growth affecting the leaf size and stem thickness. As the **PHOSPHOROUS DEFICIENCY** continues, the older, lower leaves develop irregular spots of brown to dark brown dead tissue. In some plants, reddish to purple pigmentation may appear on the under or upper surface of leaf margins, lower leaves, and stems. Eventually, leaf death of older leaves may occur. In most cases, lack of phosphorus delays flowering in plants.



control *minus K (early)*

The leaves of plants with a **POTASSIUM DEFICIENCY** are small and dark green. The plants have short internodes resulting in compact plant appearance. These symptoms are followed by a sudden development of irregular necrotic tissues along the leaf margins and tips of lower, older leaves and eventually covering whole leaves, making the leaves appear scorched. Also, leaves curl downwards.

minus Ca

Unlike other nutrients, a **CALCIUM DEFICIENCY** generally affects the growing points and young leaves of the plants. The young leaves are often twisted or wrinkled. The growth is reduced with tiny black spots appearing around the mid-leaf area of young leaves and on the tips of very young leaves. In some cases, these black spots appear on the growing points. Abortion of flowers or flower buds is common if calcium is unavailable during flowering. During fruiting, lack of calcium can result in fruit cracking, water soaked tissues or blossom end rot (tomato).

	NEW LEAF			OLD LEAF		
	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX
N (%)*	3.29	4.05	4.8	3.29	4.05	4.8
P (%)**	0.66	0.77	0.93	0.40	0.52	0.62
K (%)	3.58	4.07	4.93	3.88	4.31	5.26
Ca (%)	0.93	1.21	1.48	2.54	3.19	3.84
Mg (%)	0.31	0.36	0.41	0.42	0.52	0.65
S (%)	0.24	0.27	0.32	0.19	0.24	0.28
Fe mg/kg	78.5	94.8	120.2	84.3	120.5	169.5
Mn mg/kg	61.6	107.5	171.2	155.4	183.3	230.8
Cu mg/kg	6.0	8.0	11.4	4.4	5.4	7.6
Zn mg/kg	21.7	31.9	47.7	18.4	24.5	41.0
B mg/kg	29.8	39.7	52.7	54.9	90.1	151.9
Mo mg/kg	ND	4.5	10.6	ND	1.0	6.0
Ni mg/kg	ND	0.9	2.0	ND	1.2	2.3

* Nitrogen data taken from Mills, H.A. and J.B. Jones. 1996. Plant Analysis Handbook. Micro-Macro Publishing, Inc., Athens, GA.

** Data for all other elements obtained from Pitchay, D.S., J.M. Frantz, J.C. Locke, and C.R. Krause. 2005. Unpublished.