



# Uneven Ripening in High Tunnel Tomato

Causes and Management Solutions

Primary cause of uneven ripening is POTASSIUM deficiency in the FRUIT during early fruit set

Causes of potassium deficiency

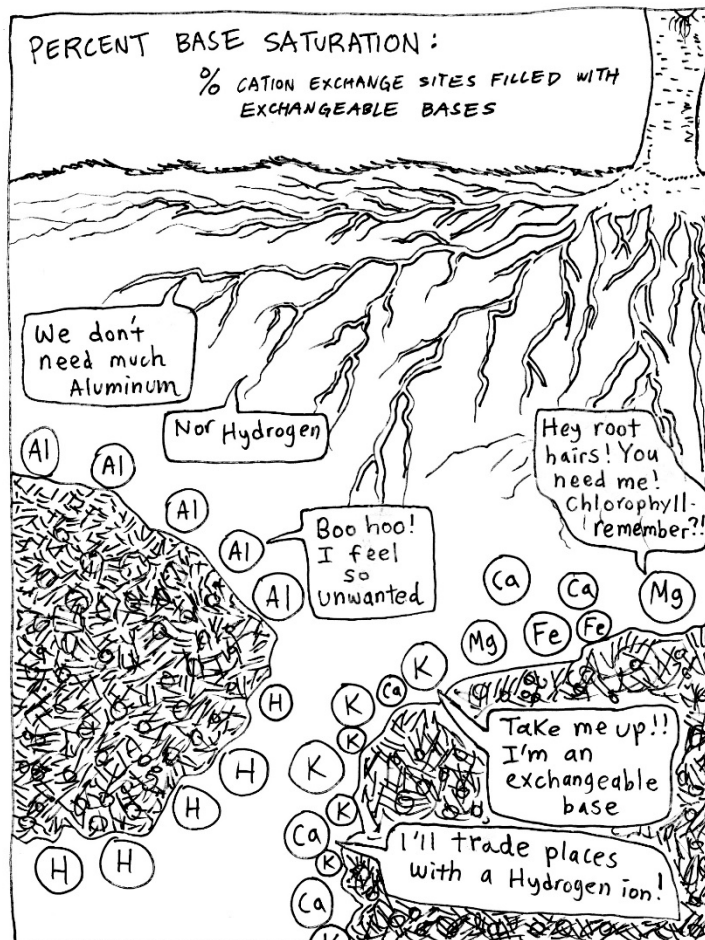
- Potassium deficiency in soil
- Excess sodium, calcium, magnesium in soil – compete with potassium for root uptake
- Excess water plus low cation exchange capacity – potassium can leach
- Excess nitrogen – during fruiting available soil potassium should be 2-3 times available soil nitrogen
- Insufficient transpiration – plants must be moving water to take in nutrients from soil

Causes of insufficient transpiration

- Lack of water
- Weak root system
- High soil temperatures – under black plastic soils can get hot enough to impair tomato root function (above 85°F)
- Excessively vigorous canopy growth (leaves out-compete fruit)
- Insufficient canopy and direct sun exposure of fruit
- High humidity in canopy
- Temperatures above 90°F in canopy

# How Potassium Uptake Works

Potassium is present in soil as a positively charged ion (cation  $K^+$ )



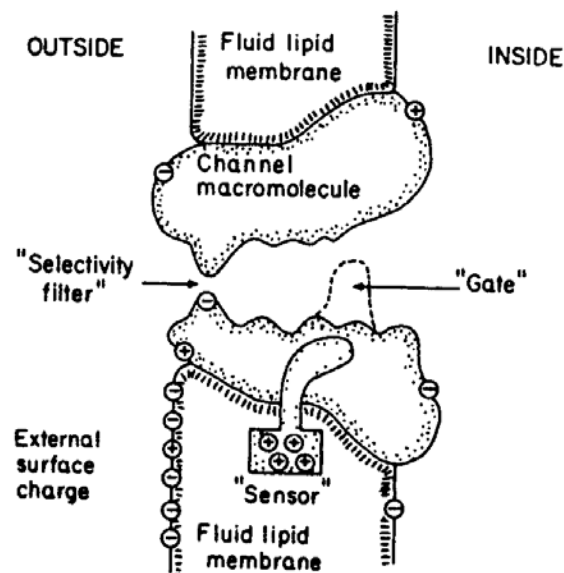
- Potassium binds to negatively charged sites on clay and organic matter in soil and to cell walls in roots
- Large size and weak bond mean  $K^+$  is easily knocked into soil solution
- Nutrients in solution are taken up by roots or leach below the root zone

Cartoon by Thomas Wang

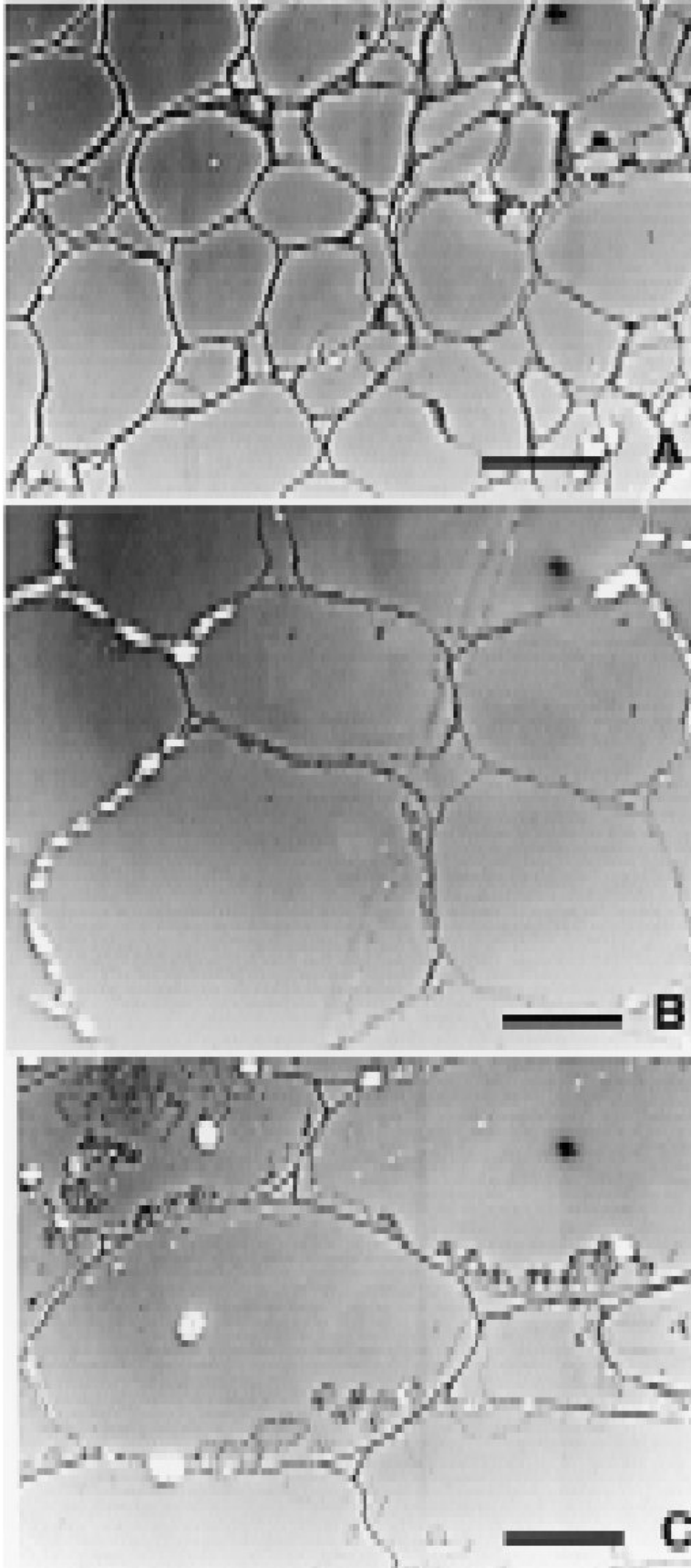
<https://missionazul.com/2015/02/20/62-soils-cation-exchange-capacity-and-colloids/>

Potassium uses special protein channels to cross cell membranes

- Must cross membrane to move from soil to xylem (transport system) and to move from xylem to fruit



- Movement across membrane is driven by difference in potassium concentration on two sides of membrane
- Concentration difference is maintained by pumping ions into and out of xylem, but this takes energy (from photosynthesis)
- Heat stress and drought stress interfere with photosynthesis and thus energy supply



Why does potassium deficiency cause uneven ripening?

Potassium is required for cell division, cell enlargement, cellulose formation and enzyme function. Cells which form under low-potassium conditions are smaller than normal and have a random, spongy arrangement.

Chlorophyll in affected cells is not broken down and chloroplasts die rather than converting to lycopene-filled chromoplasts.

Fig. 2. Light micrographs (bar = 0.2 mm) showing representative cell sizes found in tissue affected by ( A ) yellow shoulder disorder, ( B ) adjacent red-ripe tissue from the same fruit, and ( C ) tissue from mature-green fruit . All samples are from cv. Ohio 8245.

Images from Francis et al. 2000 HortScience 35(6): 1114-1117

## Preventing Uneven Ripening

1. Choose varieties with better heat tolerance and lower susceptibility to green shoulders
2. Begin monitoring tissue nitrogen and potassium levels at first flowering – tissue K should be >3% by dry weight
3. Maintain soil and canopy temperatures below 85 to 90 degrees
4. Adjust pruning to keep fruit shaded but avoid excess canopy
5. Adjust fertigation to keep potassium levels 2-3x soil nitrogen levels

## Varieties with less tendency for uneven ripening

In a 2019 trial at University of Delaware Gordon Johnson and Emmalea Ernest found that Jamestown, Primo Red, and Red Bounty had very low incidence of white tissue under high temperatures in the field, while Camaro, Mountain Merit, Mountain Fresh, Red Snapper, Marshall and Myrtle had the highest incidence. Mountain Fresh had high incidence across all five harvest dates, and Mountain Merit across 4 out of 5.



In heirloom tomatoes problems with yellow shoulder and uneven ripening have been associated with dark green shoulders in the immature fruit. Dark green shoulder is genetic.

## Monitoring tissue nutrient levels

Easiest is to submit samples of youngest fully mature leaves (usually 5<sup>th</sup> leaf from top) to UConn Plant Analysis lab. Each cultivar should be sampled separately. Aim for potassium level above 3% and Mg/Ca ratio of 1/2 or 1/3. Tissue nitrogen should be 3.5% to 4% during fruiting.

## Controlling Temperatures

Use white mulch and weedblock to keep soil cooler, or strategic watering. Monitor air temperature near top of tomato canopy. Cover high tunnel with shade cloth or add ridge vents. Maximize ventilation.

## Adjusting Fertility Program

Monitor nitrogen release from soil organic matter – consider in-season soil nitrate testing. Fertilize with potassium during fruiting – many fish emulsions are very low in potassium. Ideally the fertilizer being applied should have at least 2x as much potassium as nitrogen. Apply foliar potassium – Milstop is potassium bicarbonate, will provide potassium while preventing powdery mildew! Also apply magnesium as needed to keep Mg:Ca ratios above 1:6.

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