Physiological Disorders in Closed, Controlled Environment Crops

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Physiological Disorders--Definition

- Problems resulting from the influence of environmental and horticultural factors on plant development.
- A disorder caused by factors other than a pathogen; abiotic disorder.

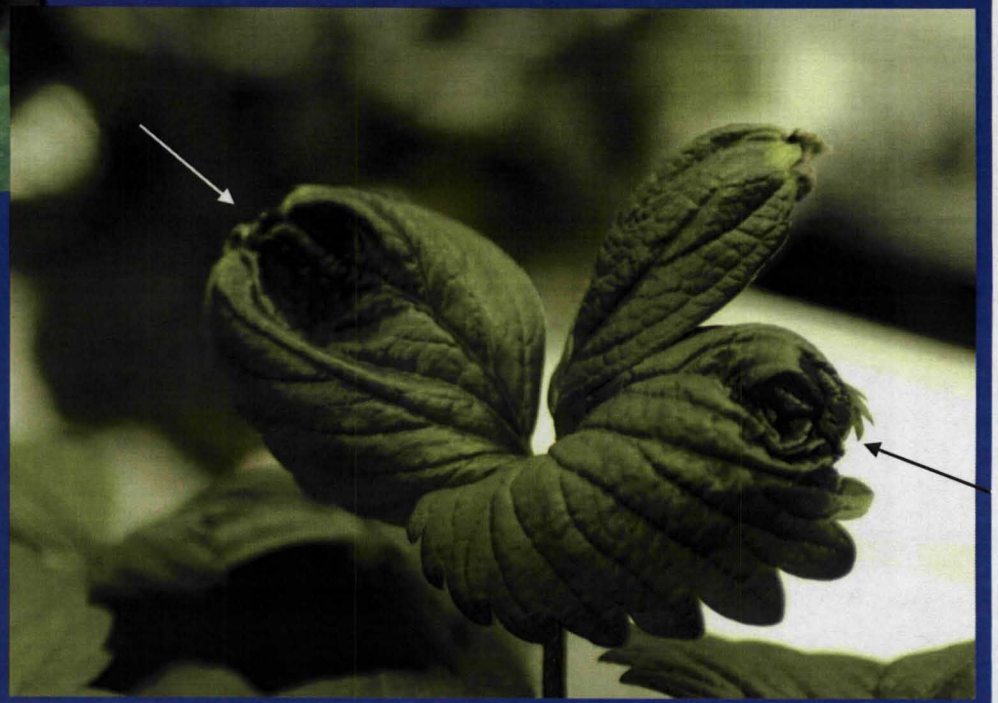
Topics Addressed:

- Calcium-Related Disorders
- Oedema (Intumescence)
- Long-Photoperiod Injury
- Light Spectral Quality Effects
- Super-Elevated CO_2 Injuries
- Ethylene
- Other Disorders
- Considerations for Closed Space Environments

Leaf Tipburn -- Other Species

Potato cv Russet Burbank

Strawberry
cv. Tribute



Note cupping or puckering of leaves at the margins

Blossom-End Rot (BER)

Pepper cv. Fruit Basket

Early Stage

Late Stage

Also common in tomato

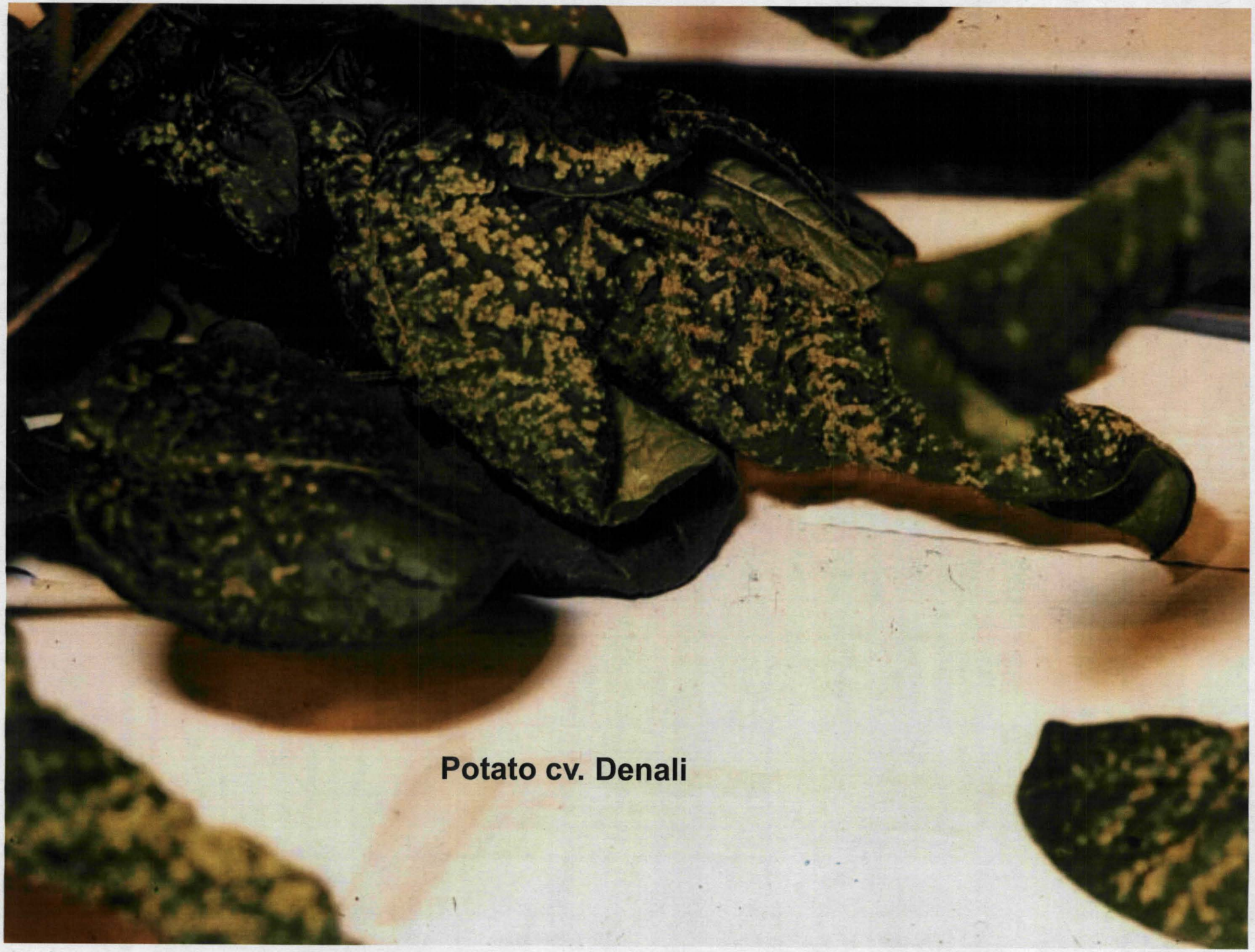
Other Ca-Related Disorders

- Black heart in celery
- Internal brown spot in potato tubers
- Bitter-pit in apple fruits
- Pillowing in cucumber fruits
- Black heart in peanut

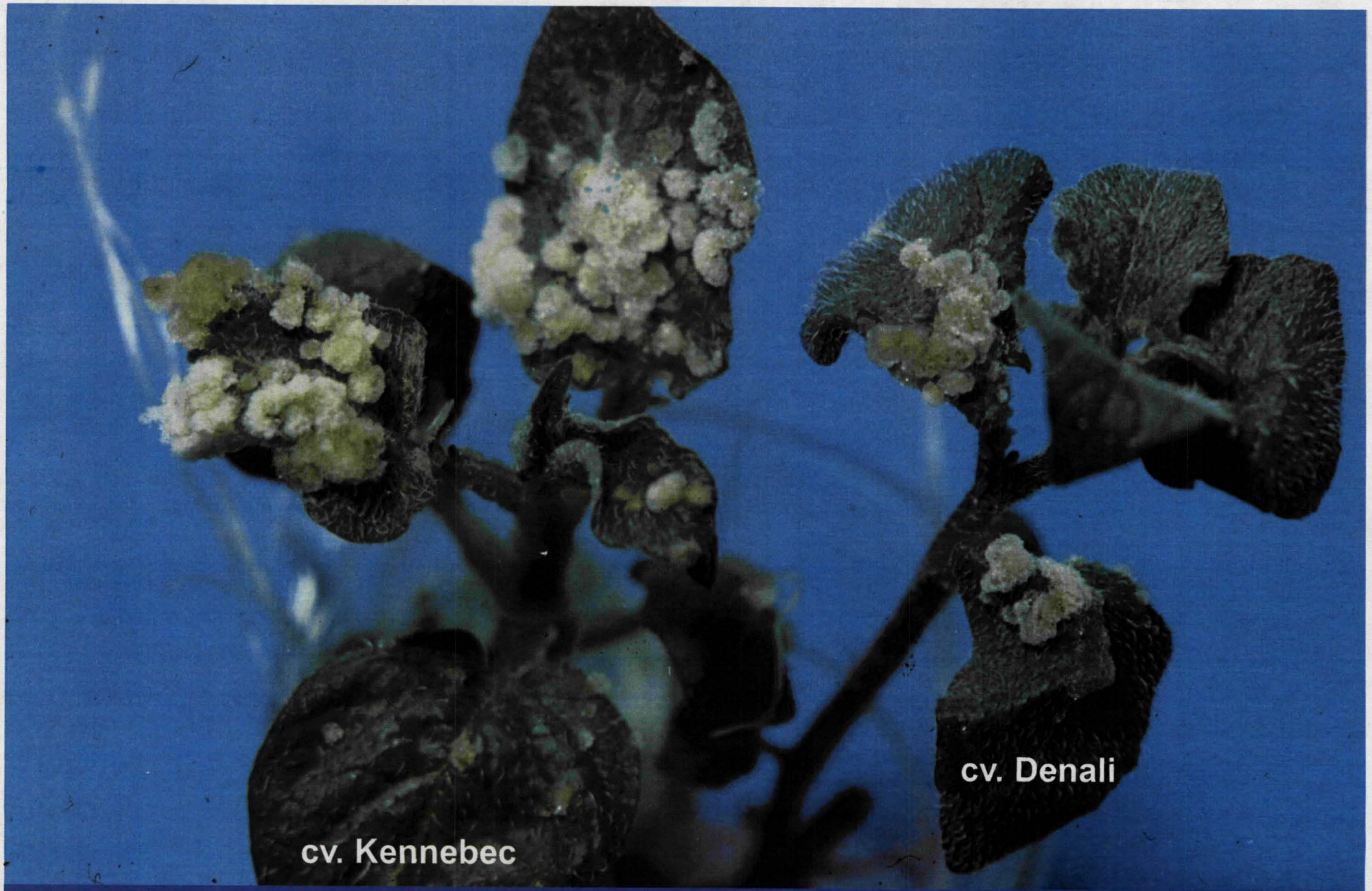
Remedial Measures for Ca-Related Disorders

- Increase air circulation to promote transpiration (Goto and Takakura, 1992; Frantz et al., 2004)
- Temperature and humidity adjustments (Ho, 2004; Saure, 2005)
- Direct Ca solution applications
- Use resistant cultivars
- Reduce the rate of growth

$\Rightarrow$ Increased Ca nutrition is typically ineffective



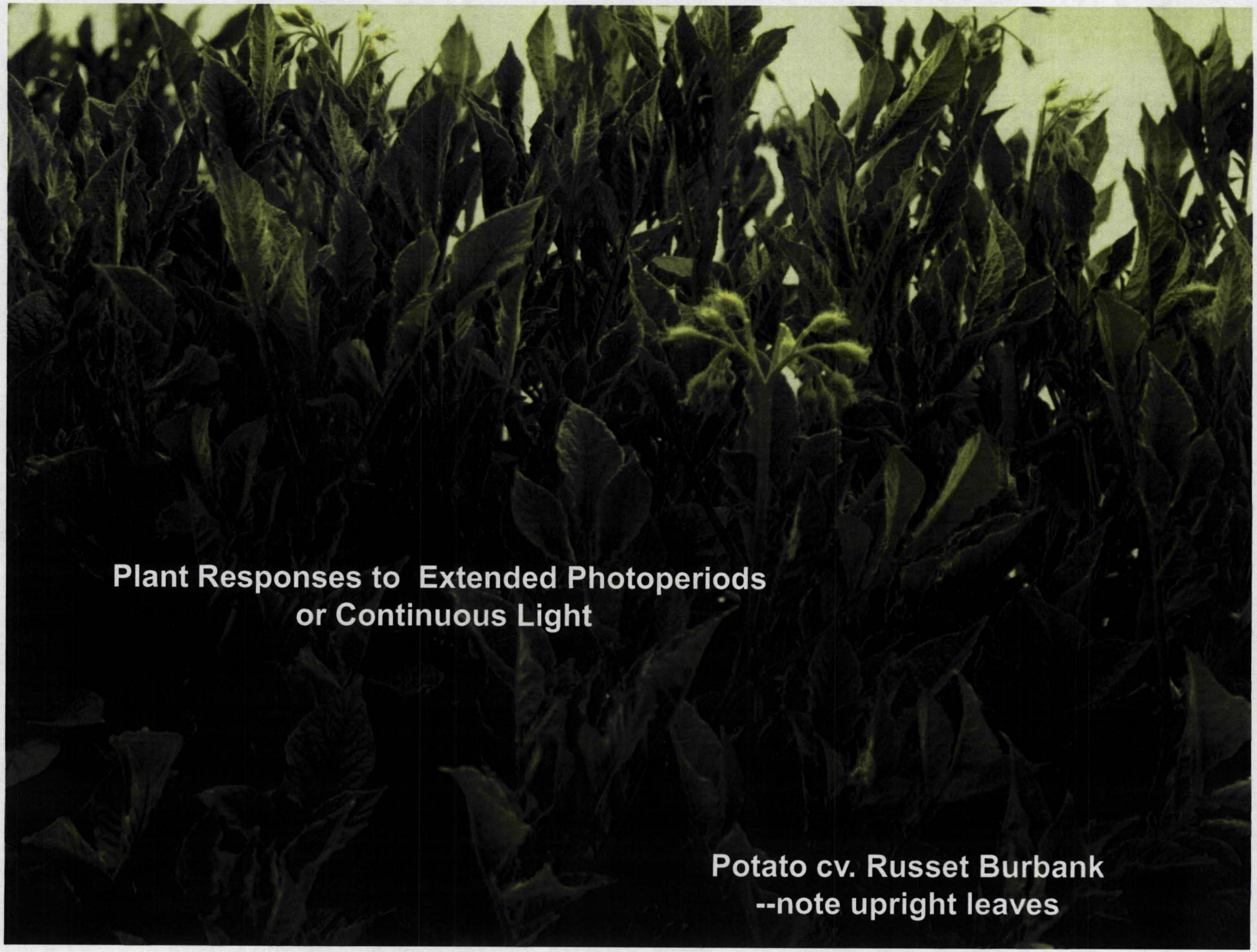
Potato cv. Denali



Oedema on Potato Leaves in Tissue Culture

Oedema--Remedial Measures

- Provide near UV (UV-A and or UV-B?) radiation, e.g., unshielded fluorescent or MH lamps; or remove UV absorbing barriers in chambers.
- Decrease the red / far-red radiation
- Avoid over-watering
- Reduce humidity and increase air circulation
- Use resistant cultivars

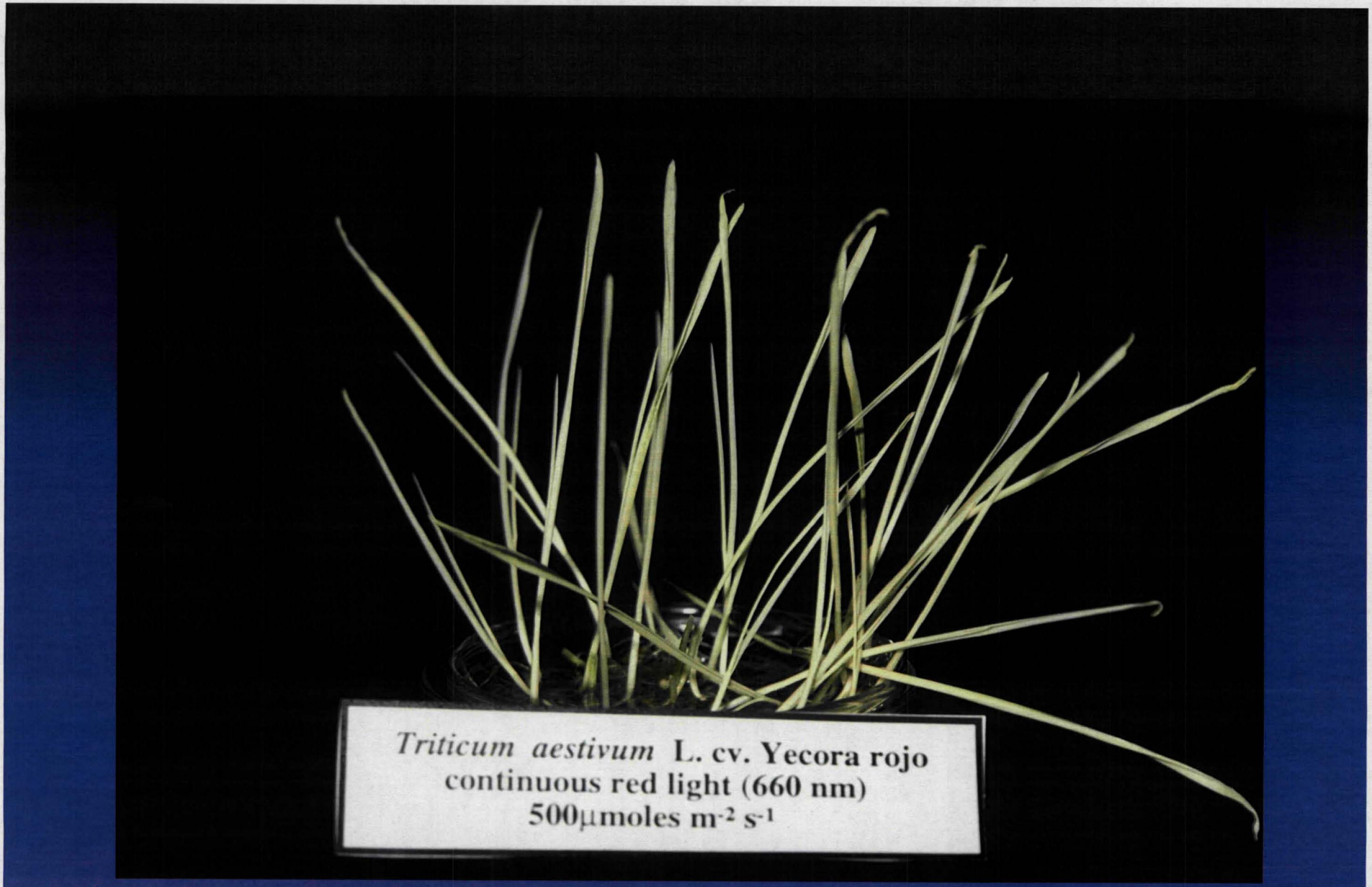

Plant Responses to Extended Photoperiods
or Continuous Light
Potato cv. Russet Burbank
--note upright leaves

Spectral Quality Considerations

45 μmol m^{-2} s^{-1} Blue Light

0 μmol m^{-2} s^{-1} Blue Light

Bleaching of Radish Leaves under Red (640 nm) Light
⇒ Addition Blue (440 nm) Prevents Injury

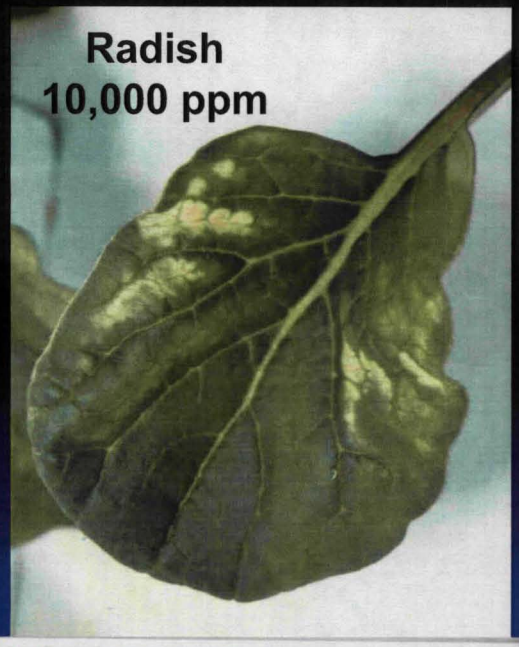


Wheat seedlings without chlorophyll--Grown under red light

Other Spectral Effects

- Far-red rich environments...longer stems
  - remove incandescent lamps
- Blue deficient environments...longer stems
  - (e.g., HPS at low PPF; LPS lamps, red LEDs)
- UV-B injury from certain types of unshielded lamps (leaf burning or scorching)

Super-Elevated CO_2 Injury to Leaves



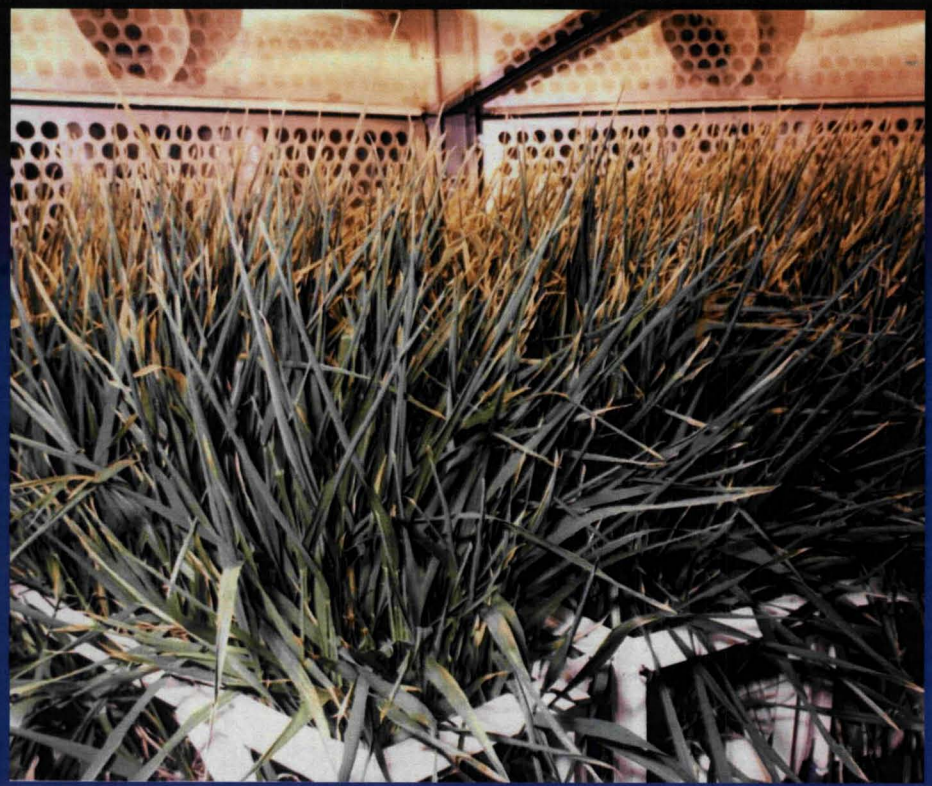
⇒ Leaf bleaching;
pre-mature necrosis

Ethylene Effects

- Fruit Ripening
- Flower Development / Abortion
- Floral Sex Expression in Cucurbits
- Stem Swelling
- Seedling Hook Opening
- Leaf Epinasty
- Leaf Abscission
- Reduced Growth

Leaf Epinasty from Ethylene

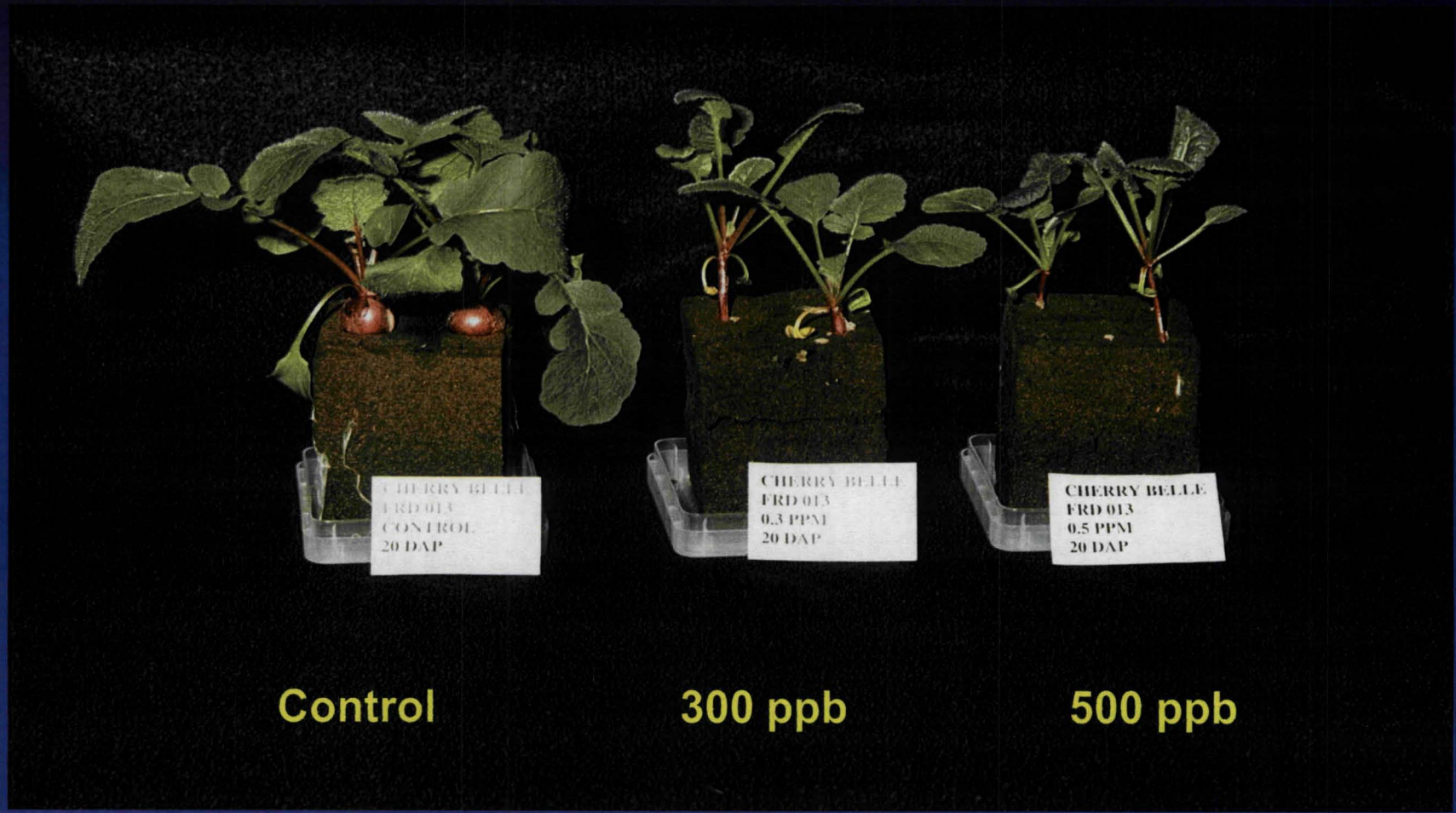
Potato cv. Denali



Wheat cv. Yecora Rojo

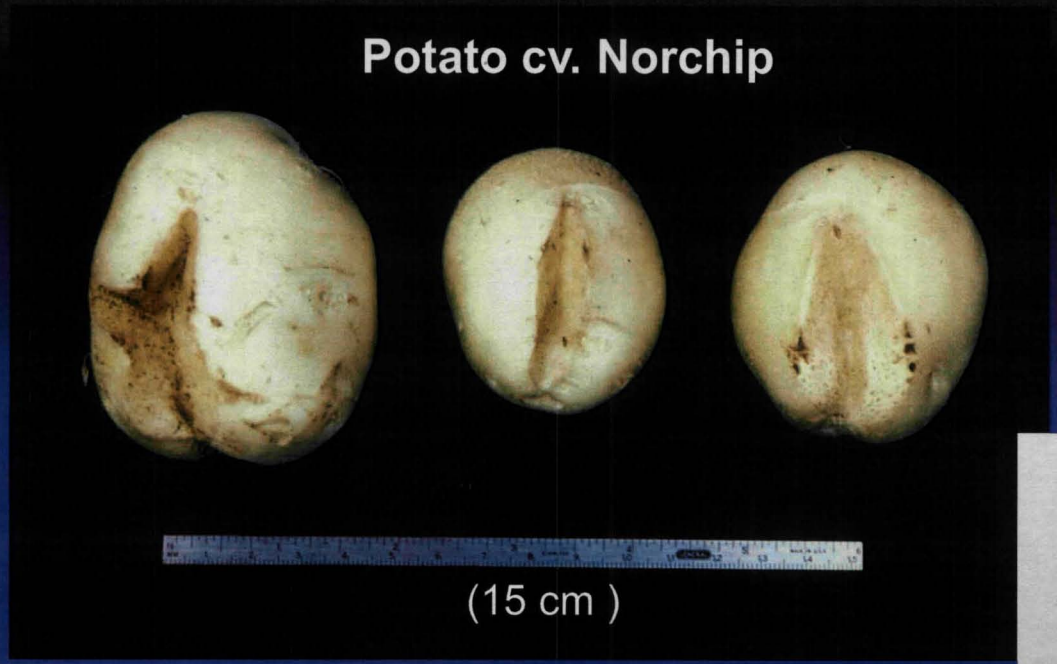
⇒ *Provide ventilation; $KMnO_4$ filters; catalytic converters*

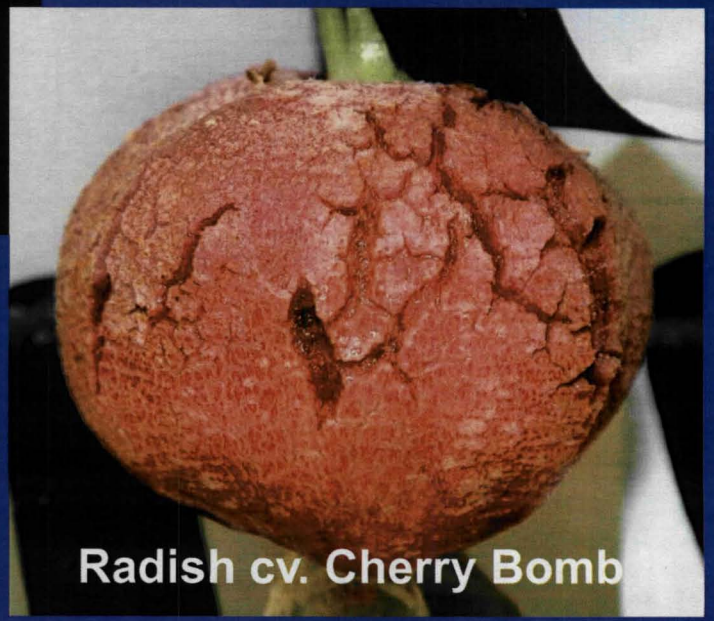
Reduced Growth at High Ethylene



(see also Klassen and Bugbee, 2004)

Growth Cracking





⇒ Harvest at earlier age
⇒ Avoid changes in watering regime
⇒ Use resistant cultivars

Can also occur in fruits, e.g., tomato