

Selenium in Plants

ADVS 5860/RLR 5860

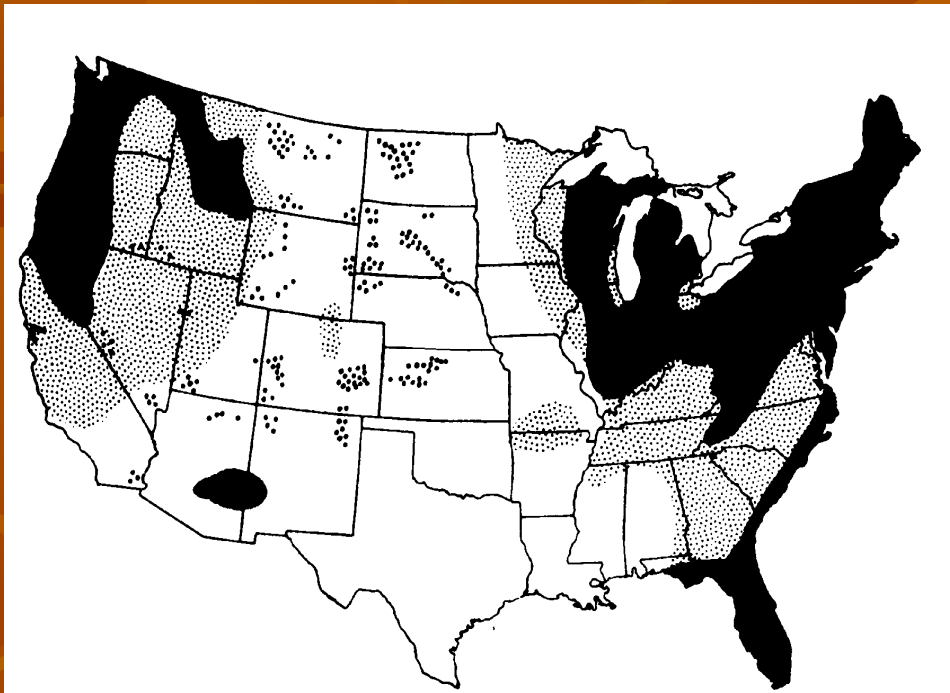
March 27, 2008

T. Zane Davis

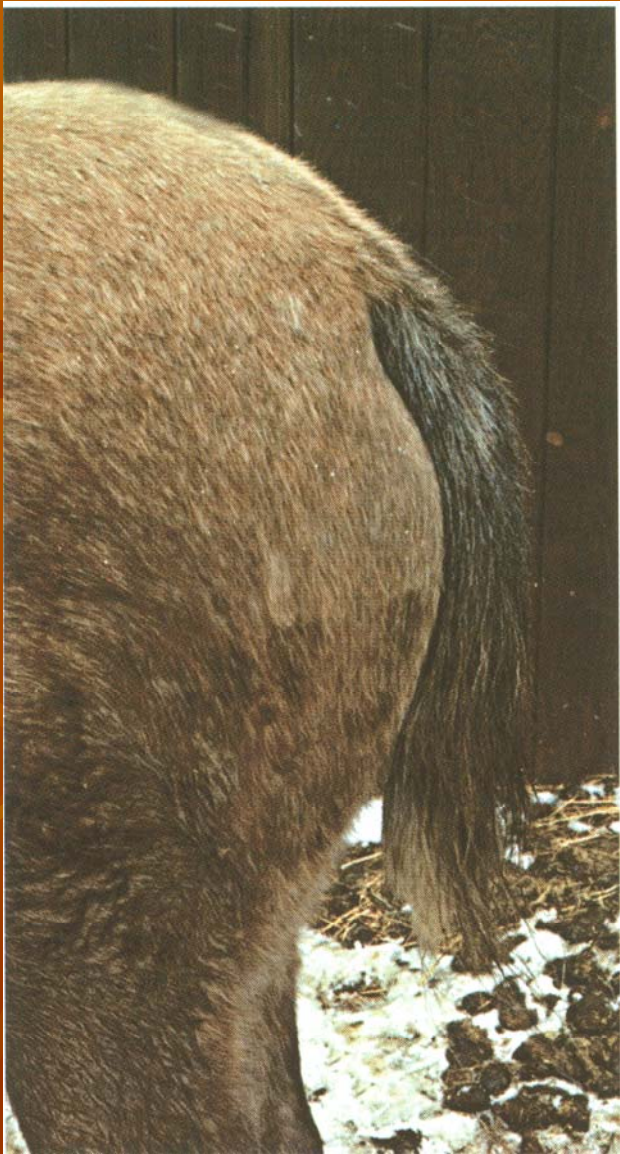
General Selenium Information

- Selenium is an essential nutrient for animals
- Deficiencies cause:
 - Immune system dysfunction
 - White Muscle Disease
 - Reproductive dysfunction
- Narrow window between deficiency and toxicity
 - < 0.1 ppm in forages may cause deficiency
 - > 5 ppm in forages may cause toxicity

Selenium Distribution

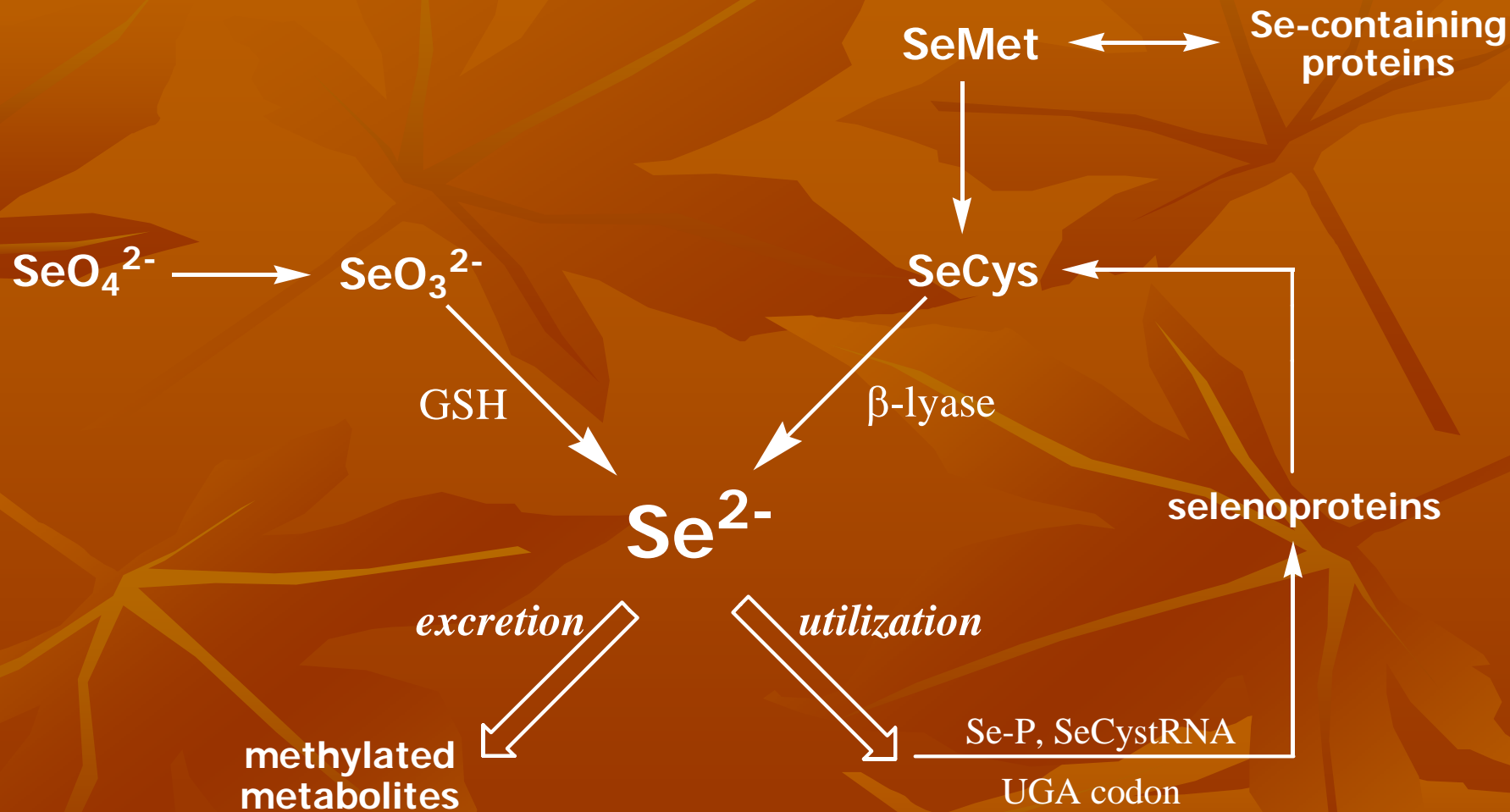


- Black- low Se (<math><0.05\text{ ppm}</math>)
- White- variable Se (0.1 ppm)
- Black dots- Se Accumulators (>math>50\text{ ppm}</math>)



Oxidation States of Selenium

- Se^{+6} Selenate- Na_2SeO_4 , SeO_3 , H_2SeO_4
- Se^{+4} Selenite- Na_2SeO_3 , SeO_2 , H_2SeO_3
- Se^0 Elemental Selenium
- Se^{-2} Selenide compounds



Selenium Accumulation

- Plants accumulate SOLUBLE selenium from the soil
 - Insoluble elemental selenium and selenides are NOT bioavailable to plants
- Selenium Indicator Plants
- Facultative Selenium Accumulators
- Passive Selenium Accumulators

Selenium Indicator Plants

- Referred to as OBLIGATE species
 - These species appear to require high selenium
 - Concentrations range from 1,000 to >10,000 ppm
- Specific indicators
 - *Astragalus* sp. (>20 different species)
 - *Xylorrhiza* sp. (woody Asters)
 - *Oenopsis* sp. (goldenweed)
 - *Stanleya* sp. (prince's plume)

Astragalus
praelongus



Astragalus bisulcatus



Xylorrhiza glabriuscula



Stanleya pinnata



Facultative Selenium Accumulators

- Accumulate selenium when grown on high selenium soil
 - Do not require selenium for growth
 - Can grow just as well on low selenium soils
- Specific plants
 - *Aster* sp.
 - *Atriplex* sp. (saltbush)
 - *Sideranthus* sp.
 - *Machaeranthera* sp. (tansy asters)
 - *Grindelia* sp. (gumweed)

Grindelia squarrosa



Passive Selenium Accumulators

- Most other plant species
- High soluble soil selenium can be toxic to some plants
- Plants that have caused toxicosis
 - Numerous grasses
 - Cereal Grains
 - Numerous weeds
 - Etc.

Selenium content of plants

- Selenium Indicator Plants
 - Up to and in excess of 10,000 ppm
- Facultative Selenium Accumulators
 - < 0.1 ppm to few thousand ppm
- Passive Selenium Accumulators
 - < 0.1 ppm to a few hundred ppm

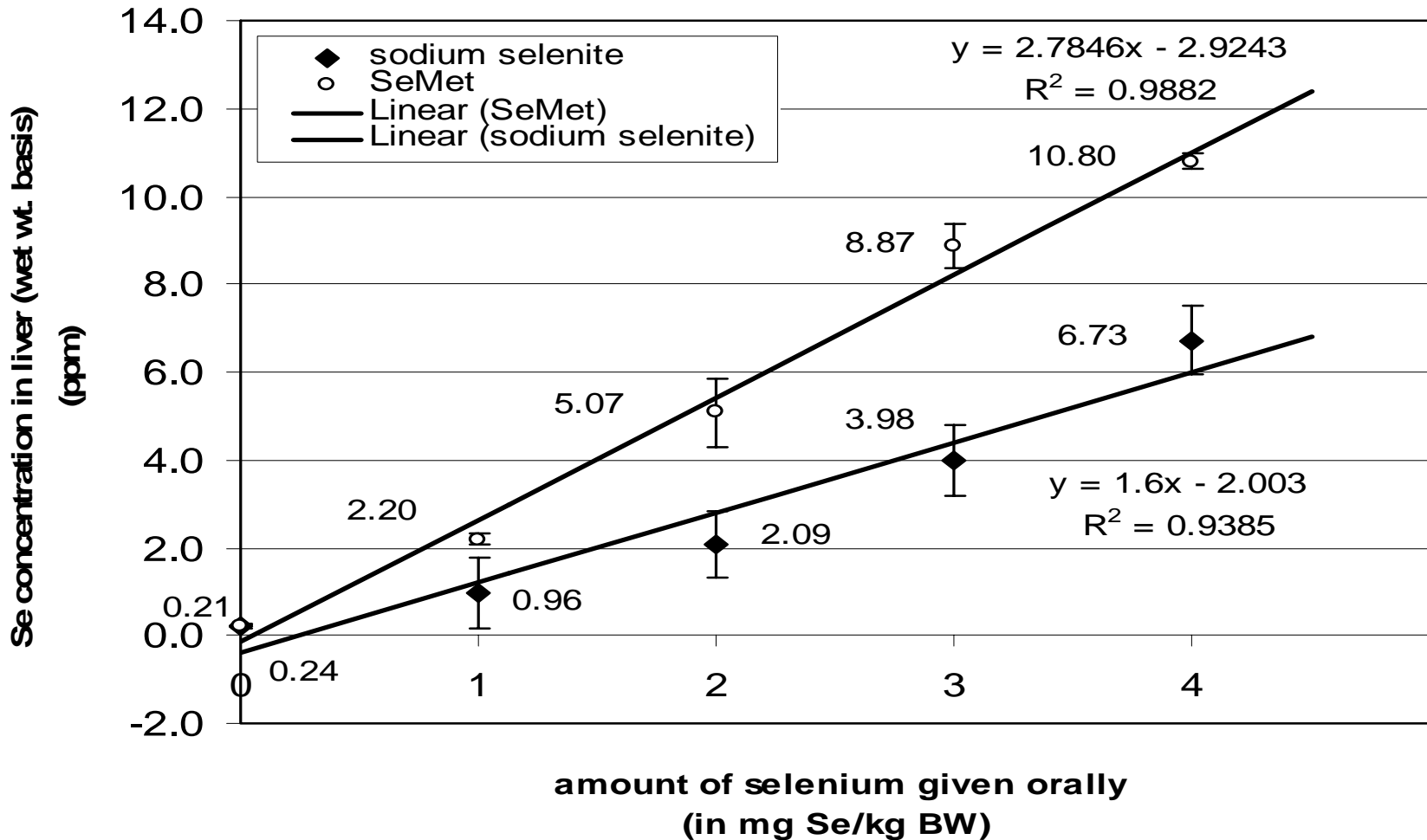


Form of Selenium in Plants

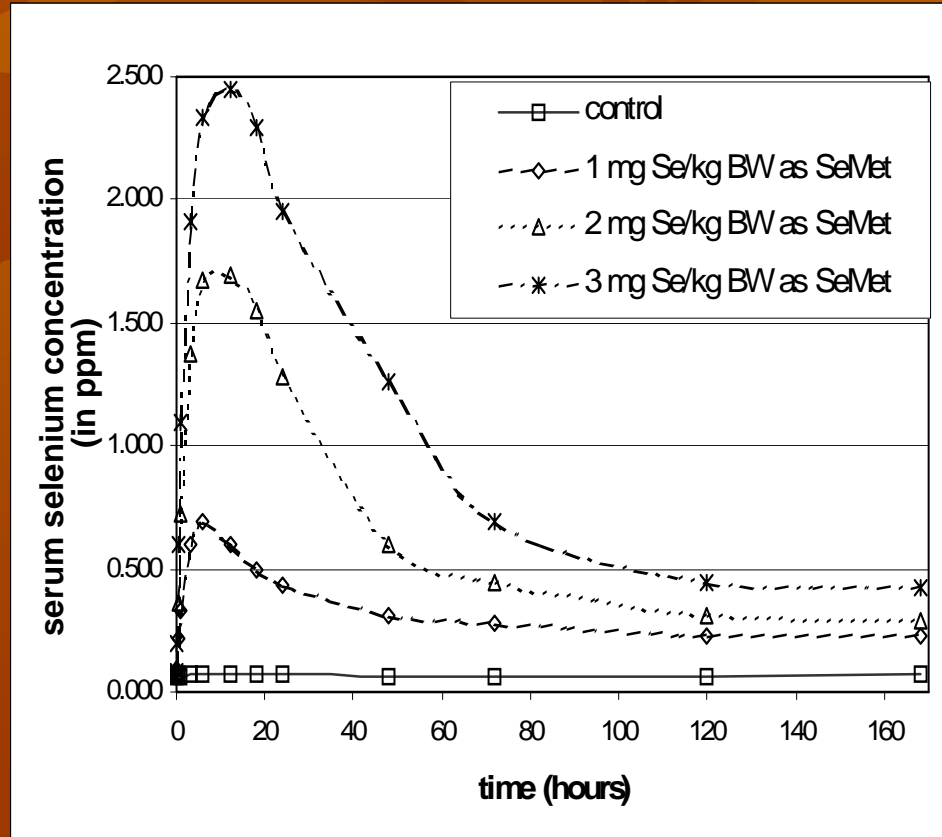
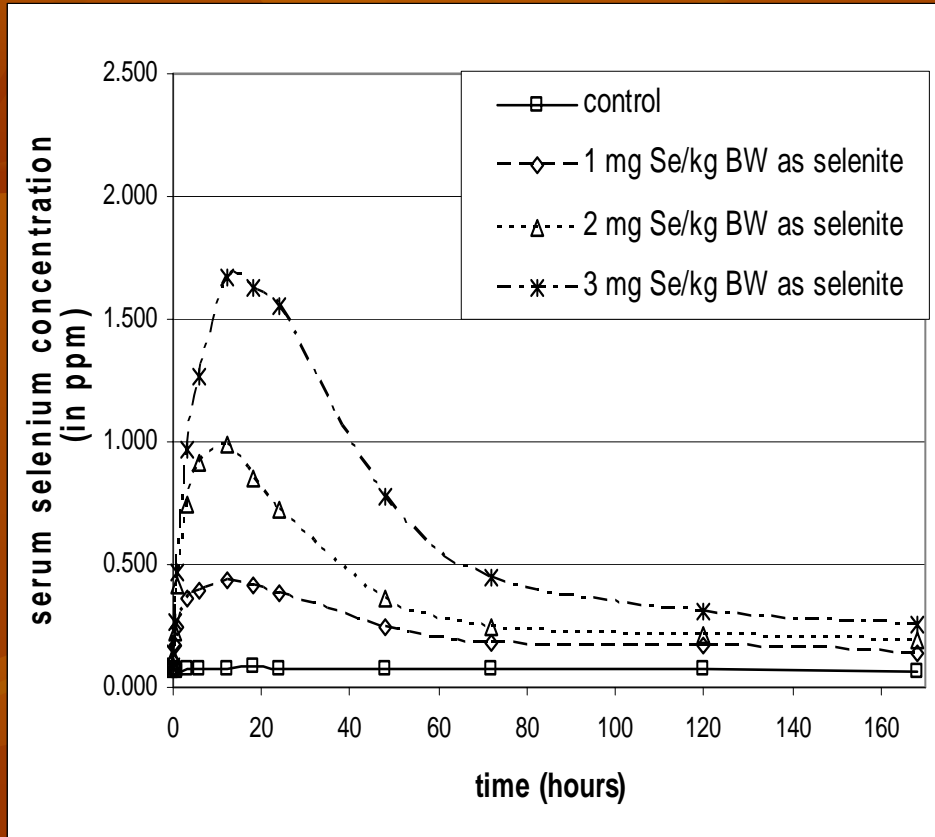
- Primarily Organic (> 80 to 98%)
 - Selenomethionine
 - Selenocysteine
 - Derivatives of the two above
 - Absorbed into animals via amino acid uptake channels
- Potentially Some Inorganic (<<<< 20%)
 - Selenates
 - Selenites
 - Absorbed into animals via mineral uptake proteins

Inorganic vs. Organic

Selenium in sheep liver



Inorganic vs. Organic



Selenium Toxicity

- Acute
 - > 0.5 to 1 mg/kg BW by injection
 - 1 to >10 mg/kg BW by ingestion
- Chronic
 - > 5 ppm in the total diet

Acute Selenium Poisoning

- Usually Obligate or Facultative Accumulators
- Clinical signs develop in a few hours to 1 day
 - Garlic like smell to the breath
 - Anorexia
 - Depression
 - Dyspnea
 - Recumbence
 - Coma
 - Death
- Death usually occurs within a few hours of signs



Chronic Selenium Poisoning

- Occurs after weeks of high selenium forage intake (> 5 to < 150 ppm)
- Once called “alkali disease” due to its association with alkaline soils
- Clinical Signs
 - Dullness
 - Hair loss
 - Lameness
 - Hoof and Joint Abnormalities
 - Anemia
 - Death due to starvation
- ??“Blind Staggers” – wandering, paralysis, dyspnea, death ??

Pathology

- Myocardial Necrosis
- Pulmonary Hemorrhage and Edema
- Passive Congestion
- +/- enteritis
- +/- systemic hemorrhage
- Hoof/joint lesions (chronic)
- Emaciation (chronic)



cm 1 2 3 4 5 6
SPECIMEN 7341 DATE 8-7-02



Selenium Interactions

- High selenium can cause deficiencies in other essential nutrients
 - Copper
 - Iron
 - Zinc

Sample Testing

- Liver
- Kidney
- Rumen or Stomach Content
- Forages
- Water

Other Plant Minerals

- Sulfur
 - Can cause Polioencephalomalasia
 - Can cause copper deficiency
 - Can cause selenium deficiency
- Molybdenum
 - Causes copper deficiency

Questions

????????

Assigned Reading: pp 305-317 in A Guide to Plant
Poisoning of Animals in North America