Diagnosing Herbicide Symptoms

University of California Weed Research and Information Center
Dr. Brad Hanson UCCE Weed Science Specialist
John Roncoroni UCCE Weed Science Farm Advisor, Emeritus

January 14, 2025
Woodland CA

Field investigations

General investigative steps

- Observe and document symptoms
  - What, when, where?
    - Photos are really helpful
      - Overviews, closeups, aerial, time progression
- Look for patterns
- Questions for growers and advisors
- Gather information about the field, area, environment etc.
- Collect samples if needed

Document symptoms

- Appearance of suspected herbicide injury
  - What do affected plants/parts look like?
- Progression
  - When did the symptoms start and how did they proceed over time?
- Relationship to field operations
  - Weed management and others?
  - What else was going on in the field, neighboring areas, or with the weather?
- Consider other biotic and abiotic disorders

Look for patterns

- In the field
  - Is it localized to part of the field?
  - Scattered or consistent?
  - Whole rows or cultivars?
  - Correlated with soil types in field?
  - Tank size of field sprayers?
  - Are multiple crop and weed species affected?

Patterns of injury (in the field)

- Aerial views can be really helpful!
- Field edges worse, symptoms fade towards interior
  - Look for possibly drift from adjacent area?
- Injury symptoms correspond to field traffic patterns
  - Look for over treatment, overlaps, incorporation or planting issues, irrigation-related, injury that corresponds to spray tank load size,
- Discrete areas of field affected
  - Are there soil differences, topography issues, etc? Gusty winds or equipment problems? Water issues?
- Whole fields uniformly affected
  - Not as likely to be drift. If herbicide, more likely self-inflicted. But also could be non-herbicide issues (biotic or abiotic)

Patterns of injury (in the plants)

- What plant parts show the symptoms?
  - New leaves or old leaves (or both) affected?
  - What part of the leaves show symptoms?
    - Margins, veins, interveinal area, older/newer tissues, overall?
  - Where did symptoms first appear and how did that progress over time?

Describing symptoms

- Some common symptoms:
  - Chlorosis (general, spotty, veinal, interveinal)
  - Discoloration (bleaching, reddening, bronzing, etc)
  - Necrosis (general, spotty, marginal)
  - Stunting (whole plant, individual leaves)
  - Epinasty (leaves, stems, petioles, callus formation, cracking)
  - Leaf or stem malformations (swelling, cracking, buggy-whipping, trapping, curling, cupping, strapping, feathering, etc)
  - Internode shortening or elongation
  - Excess branching
  - Delayed (or accelerated) maturation
  - Fruit, flower, or leaf drop

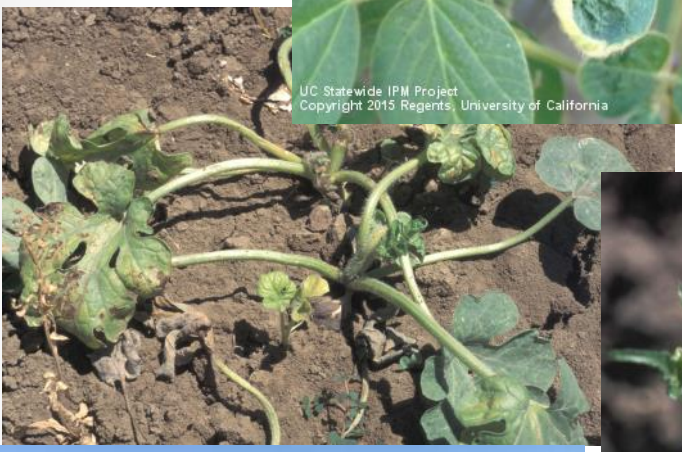
Chlorosis/yellowing: general, streaking, spotting

Necrosis (marginal, spots, and general)

Bleaching from soil-applied clomazone or norflurazon

Bronzing, reddening, bleaching

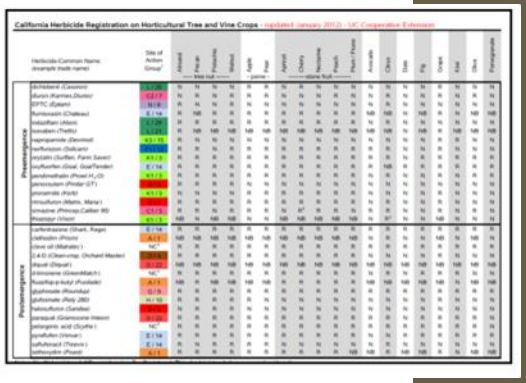
Shortened internodes, “stacked” leaves



various forms of epinasty:cupping, twisting, trapping, strapping, etc

Do symptoms "make sense" from herbicides known to be used?

- Herbicides with "contact" activity
- Translocated herbicides
  - Xylem-mobile
  - Phloem-mobility
- Mode and site of action – where does it work?
  - Young tissue (meristems), older tissues, photosynthetic tissues, etc
  - This may provide a clue as to where symptoms occur (or are the most obvious)



Gather information

- Crop variety, age, planting dates, etc
- Herbicides use, other pesticides, irrigation and fertilization, production practices
  - Application dates, rates, equipment
- Previous crop and herbicide history
- Soil type and soil test info
- Relevant weather information
  - Before, during, after suspected herbicide exposure
- Nearby potential sources of drift?
- Are multiple weeds and crop species similarly affected?
- Are there similar fields nearby that are or are not similarly affected?
- Look for “skips” or non treated areas for comparison

Weather conditions

- What environmental factors can influence herbicide injury?
  - For drift?
  - For in-crop exposure?
  - For carryover?

Consider other plant disorders

- Subtle herbicide symptoms can be confused with a number of non-herbicide problems
  - Biotic issues
    - Pathogens, insects, nematodes, vertebrate pests
  - Many abiotic disorders can mimic herbicide injury
    - Too much or too little water
    - Macro- or micronutrients (tox. or def.)
    - Soil compaction/crusting
    - Root damage from cultivation

Zinc deficiency on plum (photo R. Duncan)

Collect samples

- Consider collecting samples and storing frozen in case analyses are needed in the investigation
  - Samples can be discarded if not used but cannot be collected later if they are needed
- Sample several symptomatic and asymptomatic plants from the site
  - Document sampling locations, by whom, what procedures were used to collect and store
    - This may be evidence
  - The lab will need to know what to look for – there are no generic “herbicide” tests

Symptom variability

- Symptoms can vary widely among:
  - Species
  - Dose/rate
  - Time since exposure
  - Route of exposure

Chlorsulfuron PPI, POST, and diminishing doses PRE and POST

0.5x applied PPI

0.5x applied POST

1/128x up to 1x applied PRE (front) or POST (back)

Cautions: visual symptoms, analytical detection, and economic damage

- Visual injury symptoms are not always well correlated to yield reductions
- Economic damage can be difficult to measure and evaluate
  - Potential for long-term injury can vary significantly among herbicide chemistries
  - Especially early in the season (growth plasticity)
  - Annual vs perennial crops?
- Interpretation of laboratory analysis reports
  - Detection does not necessarily equal injury

Notes about analytical results

- Positive results
  - Indicates the herbicide is present
    - Very helpful in drift or off-target exposure
  - But, herbicide presence does not necessarily equal causation
    - Can be problematic in in-crop exposure
      - If used in the field, it's very likely to be "detectable" amounts in the plants
    - Don't always have solid info on "*how many ppm of a herbicide is needed to cause this much damage*?"
- Negative results
  - Also not necessarily an exoneration
    - Biologically active levels may be lower than analytical limits
    - Potential degradation during time between exposure and sampling

Consider MOA and uses

- An understanding of herbicide activity, symptomology and selectivity can provide clues during an investigation
  - Particularly to the mode of action level
  - Also to eliminate the “doesn’t make sense” herbicides from consideration
- When are herbicides used?
  - In the affected system or nearby
  - PRE vs POST
  - Can help narrow down to most likely culprits

Herbicides

Inhibitors of EPSP synthase Glyphosate

Glyphosate

Absorption &Translocation

- Readily absorbed by leaves and translocated in the symplast with the photosynthates to the actively growing areas of the plant with little to no movement in apoplast (xylem)
- No soil activity- glyphosate is tightly held to the soil particles

Glyphosate sprayed in fall

Almond Shoot in Early Spring

Bud small and yellow feathering of new growth bud breaks in the leaf axils

Roundup Applied in Fall

Note: chlorotic small leaves in new growth-

Glyphosate on Mule Ears

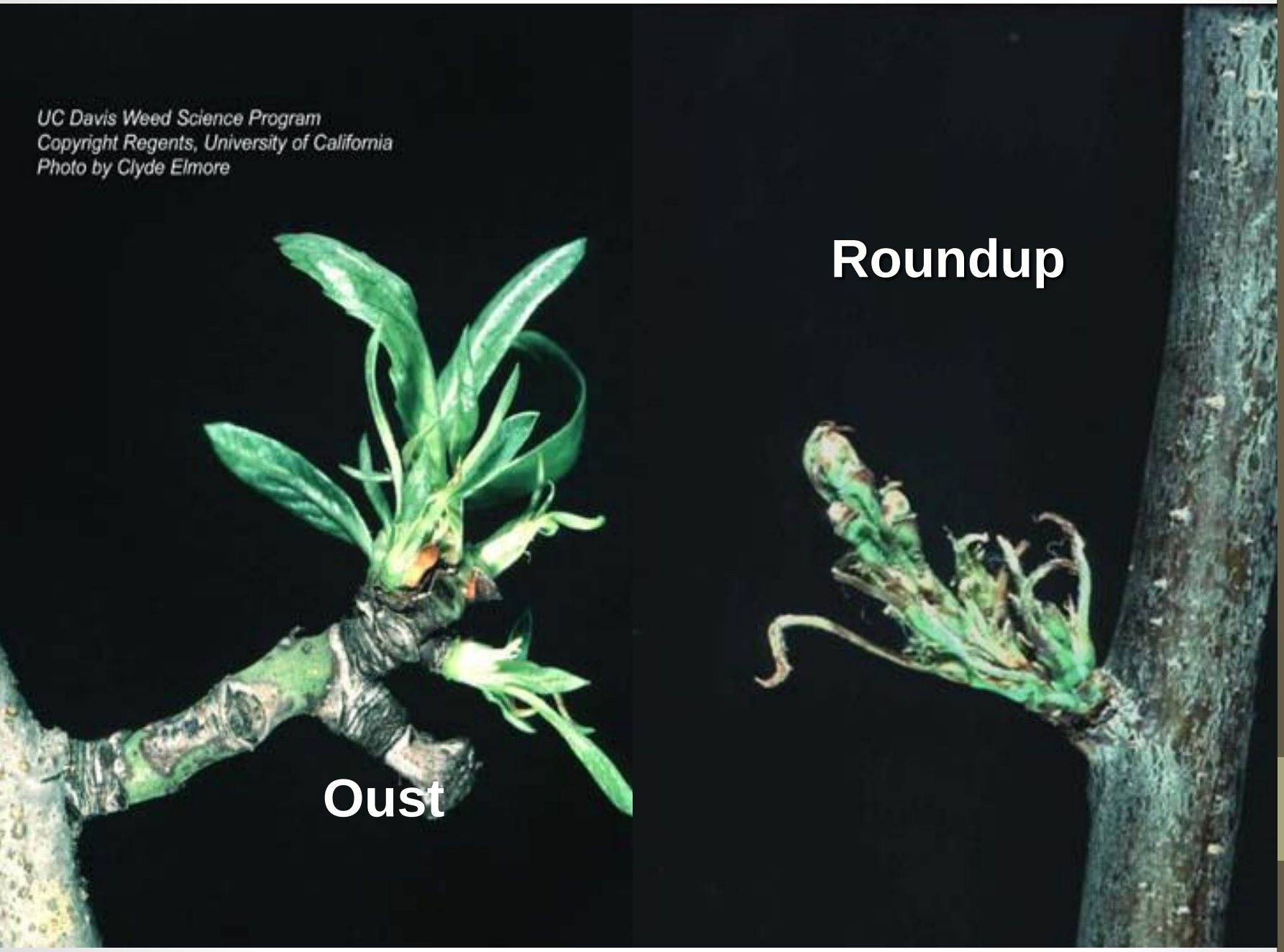
Symptoms - Inhibition of Amino Acid Synthesis (Inhibition of ALS / AHAS)

- If applied postemergence growth ceases immediately; internode length shortened
- General chlorosis, especially in immature leaves at growing point (apical meristem);
- Some grasses may turn purple in color
- Lateral bud development is often activated resulting in abnormal branching from lower nodes
- Necrosis (death) is slow, often requiring 3-4 weeks; in some cases treated plants may persist under the canopy the entire growing season in a stunted/non-competitive condition

Old leaves show no symptoms, new leaves with chlorotic and necrotic symptoms

Chlorsulfuron (Glean, Telar) applied over the top and watered in.

Almond


UC Davis Weed Science Program
Copyright Regents, University of California
Photo by Clyde Elmore
Roundup
Oust

Seedling Root/Shoot Inhibition

Example- the Acetanalides

The Dinitroanilines

- Trifluralin-Treflan,
- Oryzalin-Surflan,
- Pendimethalin-Prowl

The Dinitroanilines

Absorption &Translocation

- absorbed by emerging shoots and roots;
- have little to no POST activity
- translocation limited and not necessary because of mode of action

Selectivity

- herbicide placement that avoids contact with roots of desired plants is primary factor;
- taproot growth much less affected than lateral roots
- these herbicides control annual grasses and small-seeded broadleaves

Disruption of Mitosis

- Mitosis is the process by which nuclei divide to give two daughter nuclei with identical and complete sets of chromosomes.

Symptoms

- Germination is not inhibited but seedlings fail to emerge from soil
- Overall reduction in growth
- Swelling of the stems at the soil line- may be brittle
- Root swelling and lateral and secondary root development inhibited
- Clubbed or stubby roots

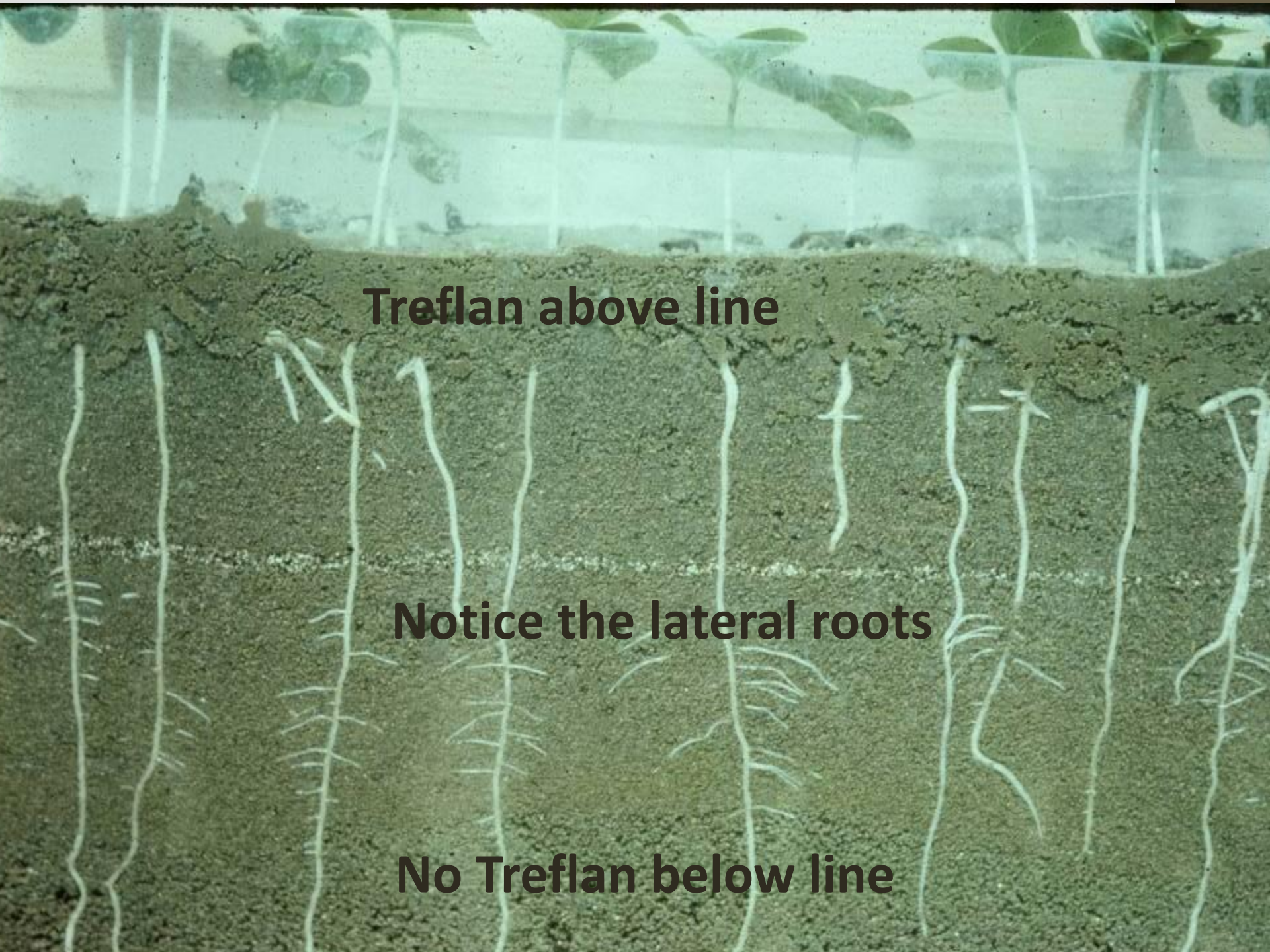
Monterey Pine Oryzalin (Surflan)

Same plants- Notice root inhibition-from Surflan

Approximate Residual Persistence of Preemergence Herbicides

Chemical name	Persistence* (months)
isoxaben, oxyfluorfen	1-4
oxadiazon	4-6
pendimethalin	2-8
oryzalin	6-10
dichlobenil, trifluralin and prodiamine	3-12

* Continue to provide weed control or remain phytotoxic to susceptible crops


Treflan above line
Notice the lateral roots
No Treflan below line

Inhibition of Protoporphyrinogen Oxidase

PPO Herbicides

Carfentrazone and Oxyfluorfen

- Carfentrazone is a Postemergence Herbicide
- Oxyfluorfen is a pre and post emergence herbicide

- Light is required for the herbicide to exert its effects, but photosynthesis is not.

- **Mode of Action**
- Protoporphyrin is present at low concentrations but is toxic to the plant at higher concentrations. When PPOase is inhibited, protoporphyrinogen (PPO) accumulates.
- In the cytoplasm, O2 radicals are formed which causes membrane disruption and plant death.

Carfentrazone and Oxyfluorfen Symptoms

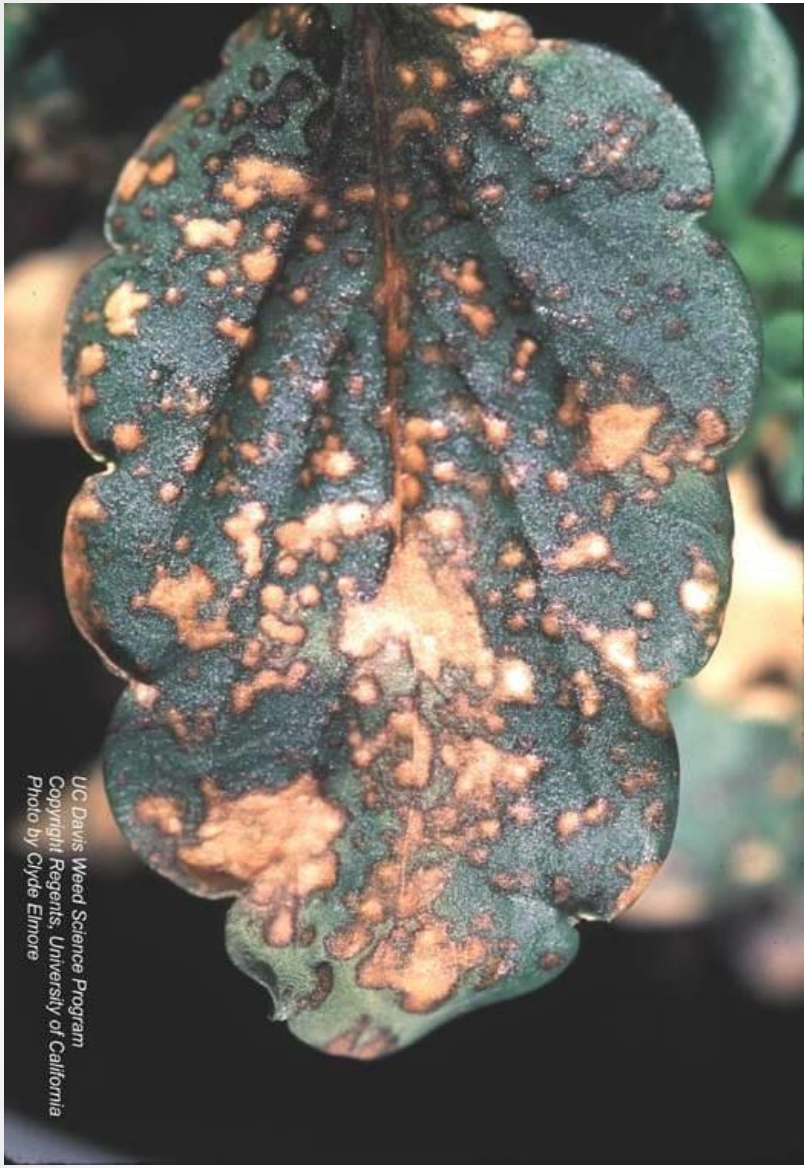
- **Foliar absorption** – contact type injury; herbicide is not extensively translocated and injury occurs in plant tissues contacted
- Injury noted as a bronzing of leaves (tolerant plants) and chlorosis followed by necrosis within 1-3 days for susceptible plants

- **Root absorption** – reddening of foliage can occur, susceptible plants die very rapidly (chlorosis followed by necrosis)

spotting on old leaves-
herbicide not moved to new leaves

English ivy cafentrazone-

Violet



Goal-Oxyfluorfen

Shark-Carfentrazone

Auxin Type Plant Growth Regulators

The Pheoxy, Benzoic and Picolinic Acid Herbicides

Plant Growth Regulators

- Auxins are a class of naturally produced plant hormones. These compounds regulate many processes in the plant, including cell growth and differentiation.
- It is often said that plants exposed to herbicides with this mode of action “grow themselves to death”.
- Herbicides in this group are primarily used to control broadleaf weeds and have limited activity on grasses.
- Even though 2,4D is applied postemergence it can have significant preemergence activity on both grasses and broadleafs.

Plant Growth Regulators

Mode of Action

- Precise mode of action is still in question.

  Plant responses observed include:

- increased protein synthesis,
- cell wall loosening and cell enlargement
- uncontrolled cell division and growth
- increased ethylene production

Plant Growth Regulators Symptoms

Broadleaf weeds (sprayed when actively growing) can have:

- Epinasty – downward twisting and curvature of stems
- Stem swelling and elongation cracks and splits in bark of woody plants
- Leaf strapping, cupping, and curling
- Chlorosis in growing points, wilting, and necrosis
- Initial symptoms observed within hours after application; three to four weeks may be required before plant death occurs

Dandelion twisted by 2,4-D

Grape

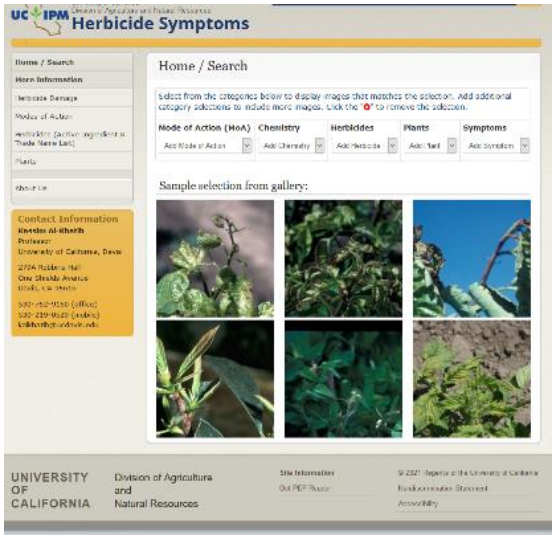
2,4-D sprayed in Late Fall or Winter on green wood-symptom in Spring

Herbicide symptomology training

- Training and photo sets to help diagnose field problems suspected to be related to herbicides

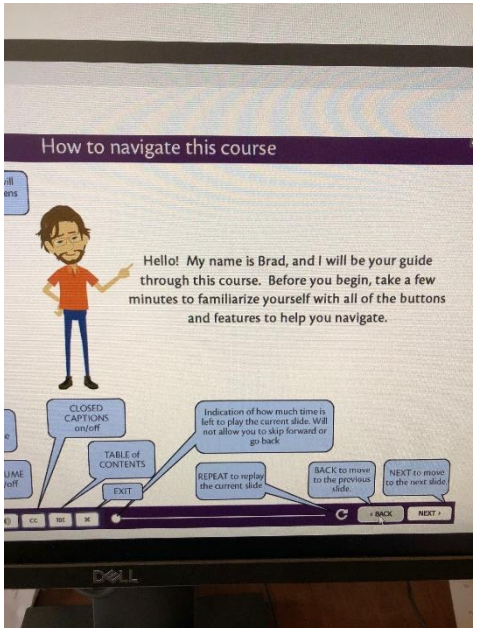
WRIC herbicide demo & diagnostic training:

- Weed Day (annually)
- UCD Weed Science School
- Diagnosing Herbicide Symptoms



UC IPM Herbicide Symptoms

- Photo database and search tool



NEW! UC IPM Training Module

- Diagnosing Herbicide Injury