# Controlling Weeds & Physiological disorders

Andy Robinson
NDSU / U of Minnesota
@Spudology z.umn.edu/spud

# Weeds

- Weeds can cause up to 73% yield loss in potato.
- Battling weeds, use IPM

# How do you win the weed war?






# Topics

- Weed control in potatoes
  - Integrated pest management (IPM)
- Physiological disorders in potato

# Integrated Pest Management

Integrated Weed Management is defined as the use of a range of control techniques, embracing physical, chemical and biological methods in an integrated fashion without excessive reliance on any one method (Powles and Matthews, 1992).

# Weed control methods (the toolbox)

- Prevention
- Cultural
- Mechanical / physical
- Chemical
- Biological

# Prevention and cultural management

- Crop rotation
- Planting configuration
- Removing debris and soil from equipment
- Proper watering and fertilizing of crop
- Growing competitive plants

# Rented land – what ask about

- Previous crops
- Tillage practices
- Herbicides used
- Common weeds
- Weed control problems

# Mechanical and physical weed control

- Tillage / hilling
  - Remove emerging weeds
  - Reshape hill
  - Incorporate herbicides
- Hand weeding
  - Kills all weeds – no resistance to this method

# Historical Primary Weed Control Method

| Product region (US) | Mechanical (%) | | Chemical (%) | |
|---|---|---|---|---|
| | 1964 | 1969 | 1964 | 1969 |
| Western | 93 | 70 | 3 | 10 |
| Central | 97 | 90 | 2 | 5 |
| Southern | 80 | 30 | - | - |
| Northeast | 50 | 20 | 20 | 20 |

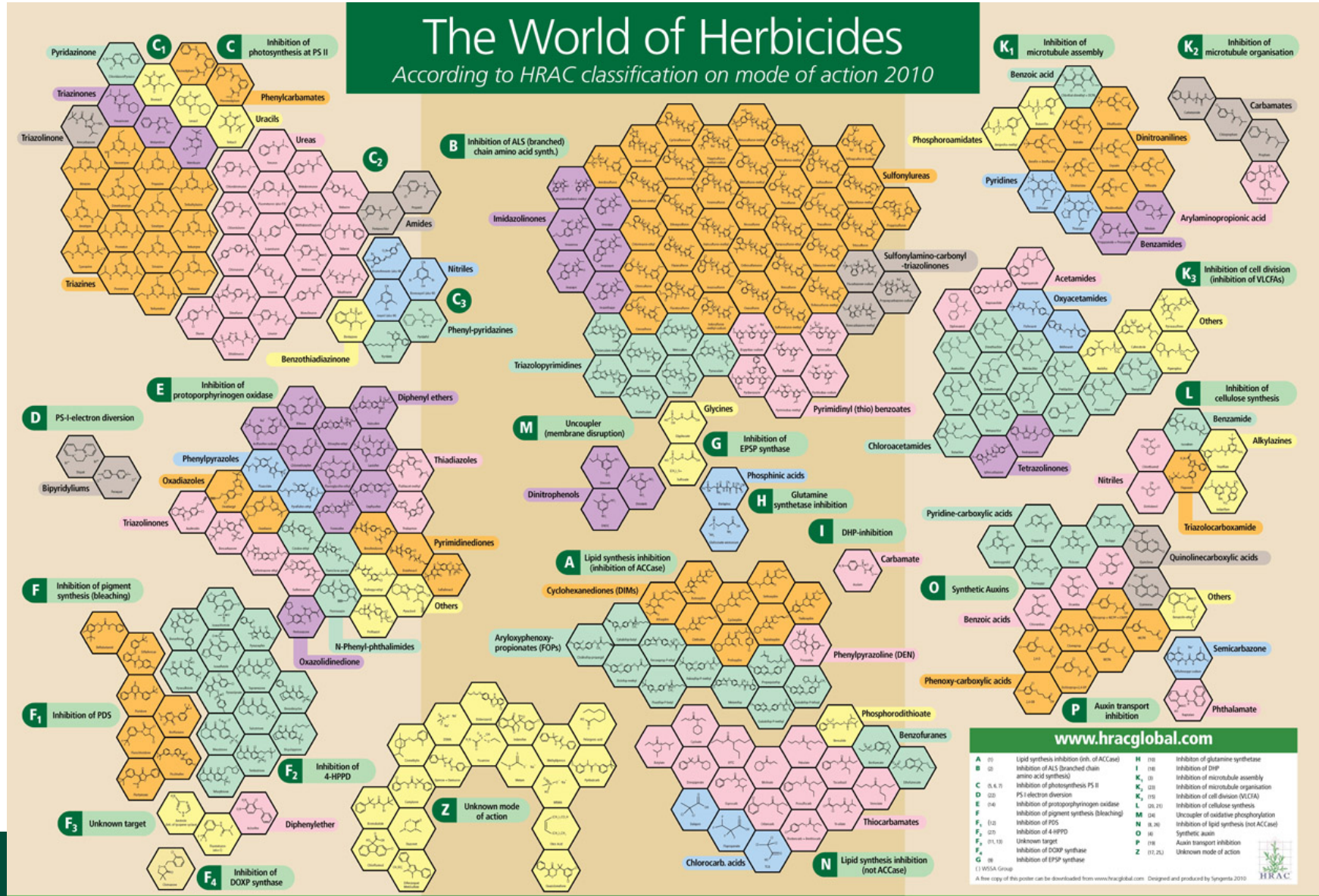
(Dallyn, 1971)

# Chemical weed control

- Herbicides

# What's the herbicide situation?

- Many herbicides, but limited for potato
- So what does this mean?




http://hracglobal.com/files/moaposter.pdf

# Preemergence modes of action

| Mode of Action | Group | Herbicide(s) | Year reported or registered | Water solubility (mg/L) | Half life (days) |
|---|---|---|---|---|---|
| Lipid synthesis inhibition | 1 / A | clethodim / Select<br>sethoxydim / Poast | 1987<br>1978 | -<br>257 | -<br>- |
| ALS inhibitors | 2 / B | rimsulfuron / Matrix | 1992 | <10 | 3 |
| Microtubule assembly inhibition | 3 / K1 | trifluralin / Treflan<br>ethalfluralin / Sonalan<br>pendimethalin / Prowl | 1960<br>1974<br>1974 | 0.3<br>0.3<br>0.3 | 164<br>34<br>44 |
| Lipid synthesis inhibition | 8 / N | EPTC / Eptam | 1957 | 370 | 9 |
| PS II inhibitors | 5 / C1 C2 | metribuzin / Metribuzin<br>linuron / Linex | 1964<br>1962 | 1100<br>75 | 21<br>60 |
| PPO inhibitors | 14 / E | flumioxazin / Chateau<br>fomesafen / Reflex<br>Sulfentrazone | 1989<br>1983<br>1998 | 2<br>50<br>780 | 15<br>100<br>211 |
| Inhibition of VLCFAs | 15 / K3 | dimethenamid / Outlook<br>metolachlor / Dual | 1993<br>1972 | 1174<br>488 | 20<br>40 |

# Postemergence modes of action

| Mode of Action | Group | Herbicide(s) |
|---|---|---|
| Lipid synthesis inhibition | 1 / A | clethodim / Select<br>sethoxydim / Poast |
| ALS inhibitors | 2 / B | rimsulfuron / Matrix |
| PS II inhibitors | 5 / C1, C2 | metribuzin / Sencor |
| Microtubule assembly inhibition | 3 / K1 | pendimethalin / Prowl |
| Inhibition of VLCFAs | 15 / K3 | metolachlor / Dual |
| Lipid synthesis inhibition | 8 / N | EPTC / Eptam |

# Selection herbicides

- Variety sensitivity
  - Minituber/NFT sensitivity
- Weed spectrum
- Timing
- Cost of herbicide and application
- Rotation restrictions

# Preemergence weed control (p.114-115)

| SOIL- APPLIED HERBICIDES* | Mode of Action** | Grasses | | | | | | | Broadleaves | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Barnyardgrass | Brome, Downy | Foxtail, Green | Foxtail, Yellow | Quackgrass | Volunteer Cereals | Wild Oat | Buckwheat, Wild | Cocklebur, Common | Horseweed (Marestail) | Kochia | Lambsquarters |
| Boundary* (Pre) | 5,15 | F-G | - | F-E | F-E | N | P | P | F-G | P | F | F-G | G |
| Chateau* (Pre) | 14 | N | F-G | P | P | N | N | N | P-F | N | F-E | F-G | G-E |
| Dual* (PPI/Pre) | 15 | P-E | P-F | F-E | F-E | N | P | P-F | N-P | N | N | N-P | P-F |
| Linex* (Pre) | 7 | F | - | F | F | P | P | P | G | P | - | F | E |
| Rimsulfuron (Pre) | 2 | G | - | G | F-G | N | G | F | P | F | P[1] | G[1] | F |
| Metribuzin* (PPI/Pre) | 5 | P-F | F-G | P-F | P-F | N-P | P-G | N | F-G | P-F | F | F-G | P-F |
| Outlook* (PPI/Pre) | 15 | G-E | P-G | G-E | G-E | N | F-G | P | N | N | N | N | F-G |
| Prowl* (PPI) | 3 | E | F-G | G-E[1] | E | N | N | P-F | P | N | N | P | F-G |
| Reflex* (PRE) | 14 | P-F | - | P | P | N | N | N | P | P | - | F | F |
| Sonalan (PPI) | 3 | E | F | E[1] | E | N | P | P | P | P | N | P | G |
| Treflan* (PPI) | 3 | E | F-G | E[1] | E | N | N | P-F | N | N | N | P | F-G |

# Preemergence weed control (p.114-115)

| SOIL- APPLIED HERBICIDES* | Mode of Action** | Broadleaves | | | | | | | | | | | Crop Safety*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lanceleaf Sage | Mustard, Wild | Mustard, Winter Annual | Nightshade, E Black | Nightshade, Hairy | Pigweed, Redroot | Waterhemp (ALS-R) | Prickly Lettuce | Ragweed, Common | Smartweed, Annual | Thistle, Russian | |
| Boundary* (Pre) | 5,15 | F | G-E | G-E | P | P | G-E | G-E | G-E | P-F | G | G-E | S-M |
| Chateau* (Pre) | 14 | N | G | G | E | G-E | G-E | G-E | F-G | N-P | F | F-G | S-M |
| Dual* (PPI/Pre) | 15 | N | N | - | N | N | F-G | F-G | N | N | N | P | S-M |
| Linex* (Pre) | 7 | - | E | - | F-G | F-G | E | G | - | G-E | G-E | F | N-S |
| Rimsulfuron (Pre) | 2 | N | F | - | P | P | E | N | - | F | P | P | N-S |
| Metribuzin* (PPI/Pre) | 5 | F | G-E | G-E | P | P | G-E | F-G | G-E | P-F | G | G-E | N-S |
| Outlook* (PPI/Pre) | 15 | N | P-F | - | F-G | F-G | G-E | G | - | N | N | P-F | S-M |
| Prowl* (PPI) | 3 | N | N | P | N | N | G-E | G | N | N | P | F-G | N-S |
| Reflex* (PRE) | 14 | - | F | - | G | F | E | E | - | G | F-G | P | S |
| Sonalan (PPI) | 3 | N | N | P | P | P | E | G-E | P | N | P | G-E | S |
| Treflan* (PPI) | 3 | N | N | P | N | N | E | G-E | N | N | P | G | N-S |

# Postemergence weed control (p. 116-119)

| POST - APPLIED HERBICIDES* | Mode of Action** | Grasses | | | | | | | Broadleaves | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Barnyardgrass | Brome, Downy | Foxtail, Green | Foxtail, Yellow | Quackgrass | Volunteer Cereals | Wild Oat | Buckwheat, Wild | Cocklebur, Common | Horseweed (Marestail) | Kochia | Lambsquarters |
| Rimsulfuron | 2 | G-E | - | G-E | G-E | G-E | G-E | G-E | N | N | N | E[1] | F |
| Metribuzin* | 5 | F | N | F | F | P | P | - | G | P | F-G | F-G | E |
| Poast | 1 | E | P-G | E | E | F | G-E | G-E[1] | N | N | N | N | N |
| Select* / Select Max | 1 | E | P-E | E | E | G-E | E | E | N | N | N | N | N |

| POST- APPLIED HERBICIDES* | Mode of Action** | Broadleaves | | | | | | | | | | | Crop Safety*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lanceleaf Sage | Mustard, Wild | Mustard, Winter Annual | Nightshade, E Black | Nightshade, Hairy | Pigweed, Redroot | Waterhemp (ALS-R) | Prickly Lettuce | Ragweed, Common | Smartweed, Annual | Thistle, Russian | |
| Rimsulfuron | 2 | - | E | E | G/N | P-F | E | N | - | P | F | P[1] | N-S |
| Metribuzin* | 5 | - | E | E | P | P | G | P-G | G-E | E | E | - | N-M |
| Poast | 1 | N | N | N | N | N | N | N | N | N | N | N | N |
| Select* / Select Max | 1 | N | N | N | N | N | N | N | N | N | N | N | N |

# Tips for maximum efficacy

- Incorporate (tillage or water)
- Timing
  - PRE: prior to emergence (follow label)
  - POST: small weeds, <1 inch tall is ideal
- Use adjuvants with POST herbicides
- Tank mix herbicides to improve weed control spectrum

# Soil factors for preemergence herbicides

- pH
- Organic matter
- Soil texture
- Soil moisture

# Timing of herbicides

- 3 – 5 week window for PREs
- Program could include:
  - Tillage / field preparation
  - Planting
  - Hilling
  - Herbicide prior to emergence
  - Postemergence herbicide

# How to optimize weed control?

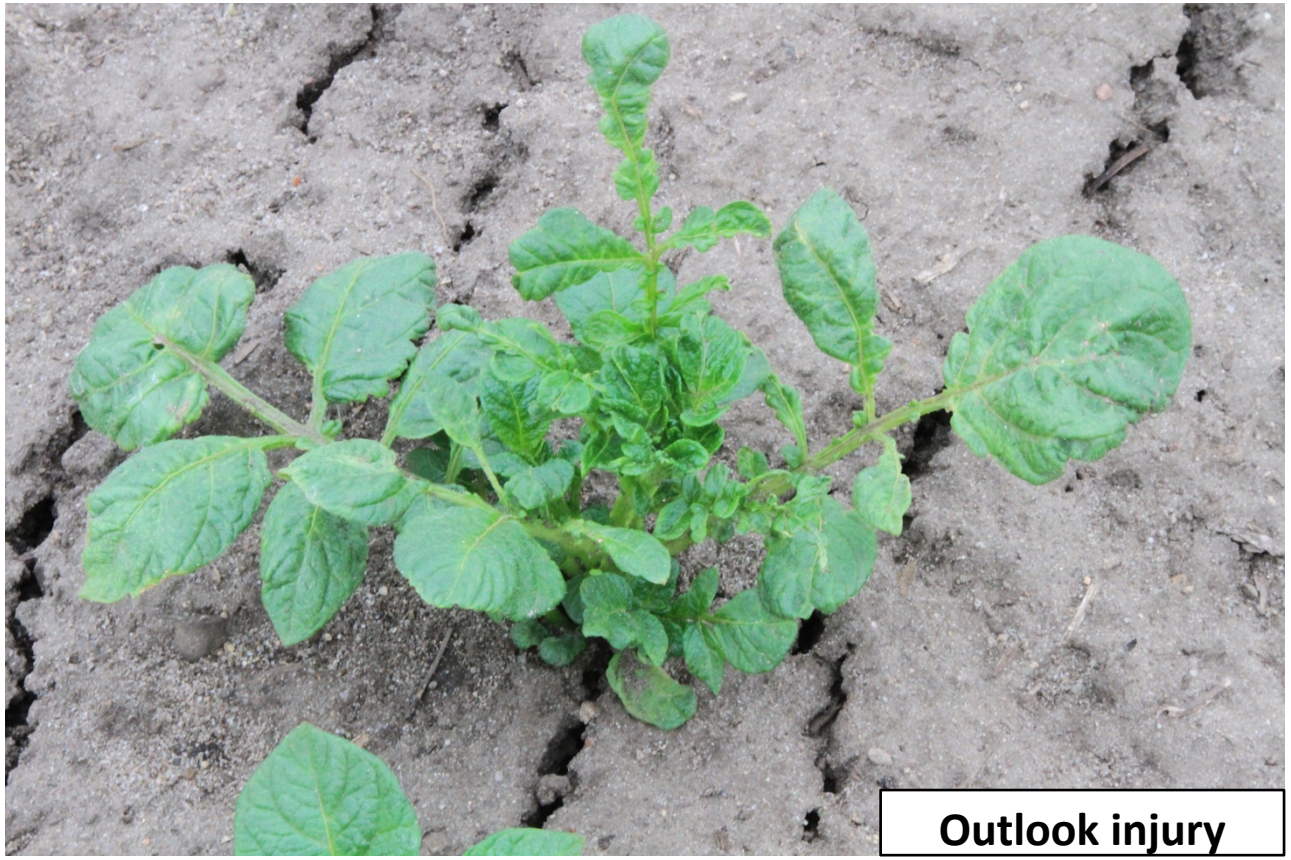
- Use an integrated weed management approach with many tools.
  - Tillage
  - Best herbicides at right time
  - Cultural management practices
  - Do not encourage herbicide resistance

# Outlook

- Inhibit proper cell division
- Very water soluble = quickly available
- Provide good to excellent control of
  - Common lambsquarters
  - Pigweed species
  - Nightshade species

# Dual/Outlook

- Bound to OM
- Broken down by soil microbes
- Breaks down quicker in warm temperatures
- Root & shoot inhibitor



Outlook injury


Outlook injury
(dimethenamid-P)

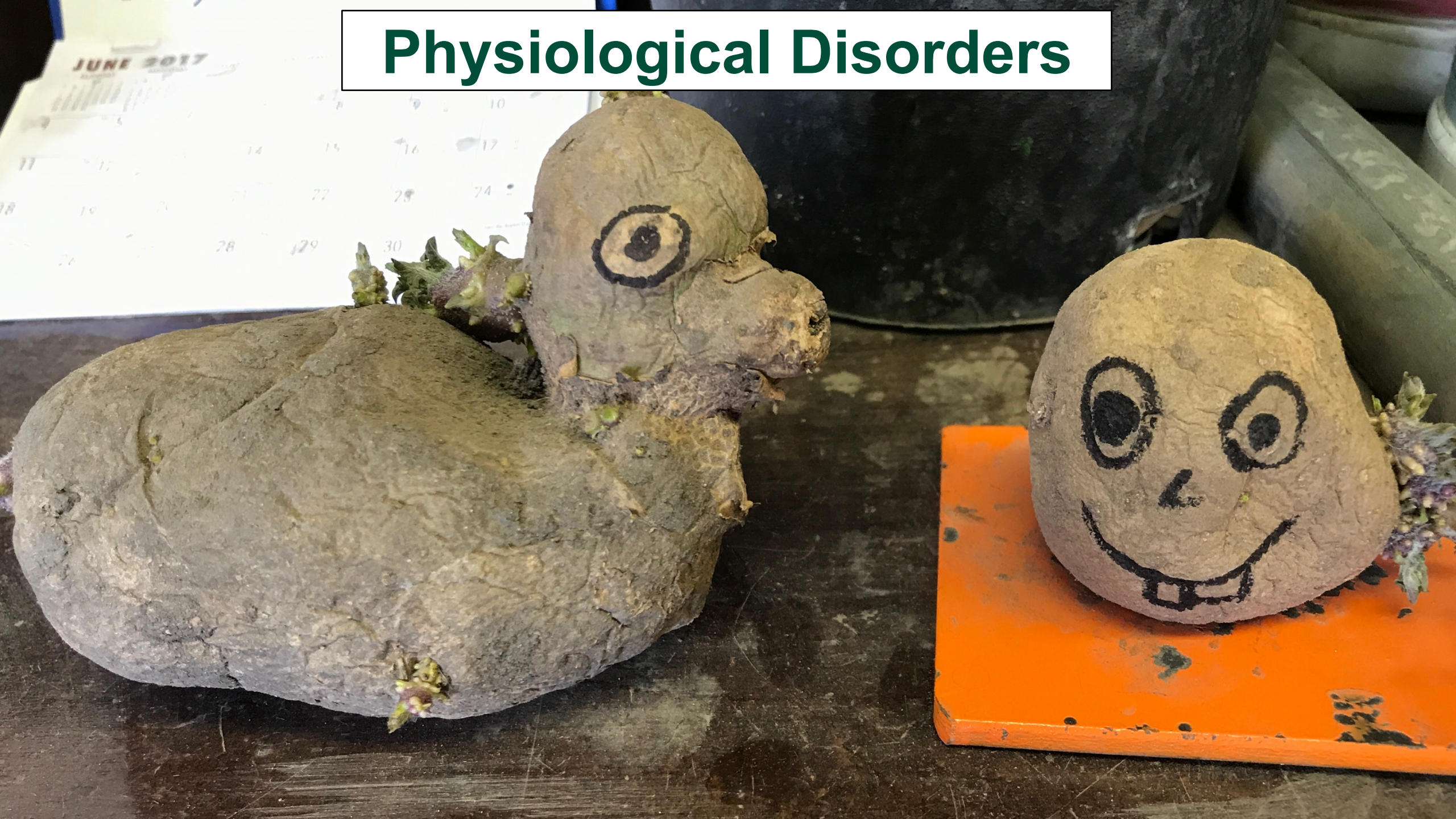
# Metribuzin activity

- More active in soils with:
  1. pH > 7.5
  2. Low organic matter
  3. Stressed plants
- Foliar: symptoms can be severe when metribuzin is applied when plant metabolism is slowed, or within 3 days after periods of cool, wet, or cloudy weather.

Metribuzin injury

# Future of weed control…

# Physiological Disorders



# What is a physiological disorder?

- Non-infectious (do NOT spread).
- Something the plant pathologists can’t identify!
- Not caused by insects or nematodes.
- Reduce quality/marketability of tubers.
- Can be on surface and/or interior of tubers.

# Physiological disorders

- Primary cause of non-infectious disorders are difficult to determine.
- Difficult to study because they are not consistently expressed.
- Chemicals or diseases may accentuate disorders.
- Can lead to secondary pathogens entering tubers.

# Bruise/Skinning

# Bruise/Skinning

- Cause: handling and storing
- Skin set is important to reduce severity
- Can cause moisture loss and entry point for diseases on tuber skin.

# Russeting/Road Mapping

# Russeting/Road Mapping

- Appearance of russet-like skin.
- Commonly found on smooth-skinned tubers.
- Result of extra skin layers to protect the tuber from heat stress.
- Some data indicate calcium can reduce this disorder.

# Enlarged Lenticels

# Enlarged Lenticels

# Enlarged Lenticels

- Caused by anaerobic conditions
- Lenticels open for oxygen and $CO_2$
- Cause ‘popcorn’ looking area and when dries appears as scab
- Opening for pathogen entry

# Tuber Cracking

# Tuber Cracking

# Tuber Cracking

- Many causes
  - Environmental stress, nutritional imbalance, disease, herbicide injury or genetics.
- Results of high turgor pressure and rapid tuber growth
- Earlier cracking = larger cracks

# Coiled Sprout

# Coiled Sprout

- Abnormal sprout development
  - Coiled, split, cracked
- Cause loss of apical dominance
  - Axillary shoots and delayed emergence
- Causes
  - Early planting, soil type, cultivar
  - Ethylene imbalance – physiological aging, disease, or microorganism production

# Freeze Damage

# Freeze Damage

- Death to foliage
- Regrowth from axillary buds
- Tuber damage can occur in late season

# Heat Crinkle

# Heat Crinkle

- Sprouts suddenly encounter high temperature and stress plant
- Can increase stem number
- More common in sandy soils
- Russet Burbank is sensitive

# Greening

# Greening

- Exposure to sunlight
- Green from chlorophyll
- Contains glycoalkaloids– cannot consume
- Hilling and cultivar selection can reduce this disorder

# Elephant Hide

# Elephant Hide

- Rough or thick coarse russeting
- Causes:
  - High temperatures, genetic traits, soil fertility, soil moisture or chemical treatments
- Diseases
  - Rhizoctonia and mop-top
- Herbicides
  - ALS chemistry and glyphosate

# Periderm Disorder Syndrome (formerly Pink Eye)

# Periderm Disorder Syndrome (formerly Pink Eye)

- Puffy, pink-colored area around eyes
- Usually found on bud-end first
- Will fluoresce when exposed to blacklight
- Excessive moisture, soil compaction and high temperature can lead to low oxygen soil conditions = cell damage

# Stem End Disorder

# Stem End Disorder

- Result of low starch content.
- Can fry dark because of increased reducing sugar levels.
- Commonly occurs on stem end.
- Result of stress-triggered mechanisms:
  - Heat, drought & fertility

# Tuber Malformations



# Tuber Malformations

- Result of:
  - Sudden growth interruption, rapid growth following a stress
- Bottleneck, dumbbell, or pointed end appearance, this is indicative of when growth interruption occurred.
- Herbicides can interrupt growth and cause malformations.

# Blackheart

# Blackheart

- Caused by lack of oxygen, leading to dark, necrotic cavities.
- Can occur during tuber development and/or storage.
- Increased temperature can intensify blackheart, especially after vine kill and when soils are saturated.

# Hollow Heart

# Hollow Heart

- Occurs in the growing season
- Precursor is brown center and can develop into hollow heart as tuber expands.
- Cause:
  - Stress growing conditions followed by rapid tuber growth.

# Heat Necrosis

# Heat Necrosis

- Likely caused by several environmental stimuli:
  - high day and night temperatures, high soil temperatures & low soil moisture
- Symptoms not observed on foliage.
- Color, intensity and area affected will increase through time and can intensify in storage.

# Internal Anthocyanin Pigmentation

# Internal Anthocyanin Pigmentation

- The same anthocyanins are naturally found in the tuber skin of red and purple potato tubers and in the flesh color.
- Not a normal, thus causes concern to farmers and consumers.

# Vascular Discoloration

# Vascular Discoloration

- Discoloration of the vascular ring at the stem end.
- Can result from rapid vine death, especially when plants are less mature.
- Verticillium and fusarium wilt have similar symptoms.

# Internal weed sprout

# Little tubers

# That's All Folks!

**@spudology**

**z.umn.edu/spud**