PURDUE
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Soil Characteristics that Influence Weed Management

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Weed Management Talks Tonight

- **Soil Characteristics that Influence Weed Management – Steve Weller**
- **Cropping Practices that Influence Weed Management – John Cardina**
- **Tools, Practices, and Materials for Weed Management – John Masiunas**
- **<u>All these topics are related but 'Soil Quality' is the basis of good or bad farming</u>**

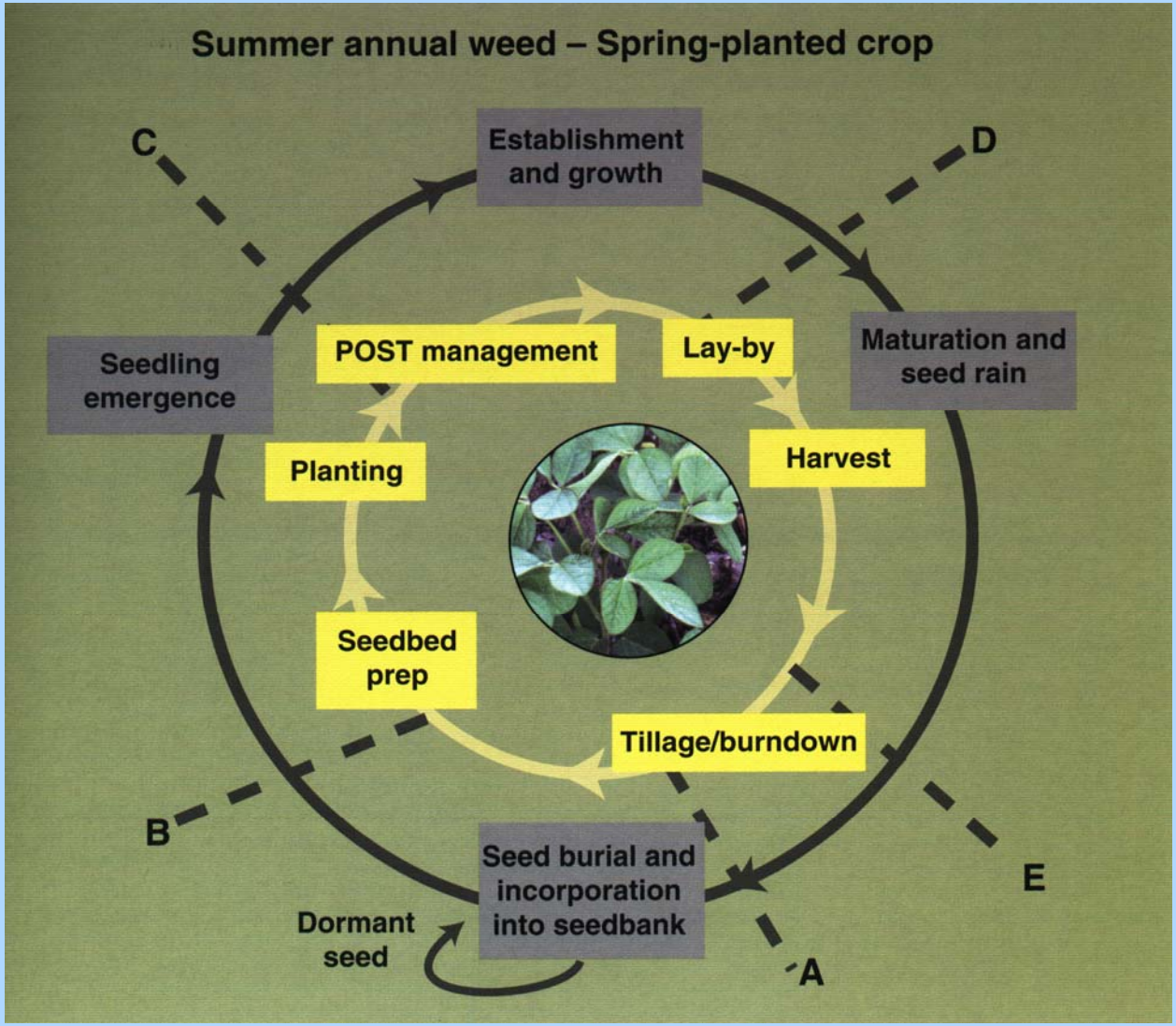
Basis of Effective Weed Management

- **Integrated Weed Management**
  - **Use of all available tools to mange weeds in agricultural fields and integration of these into an ecological approach to farm management**
    - **Basis of an effective farming system depends on maintenance of a quality soil**
    - **Soil quality affects soil factors that can affect weed presence, abundance and type**
    - **Weed management becomes more problematic when soil is improperly maintained**

Some Thoughts about Weeds

- **Weeds are a symptom of a soil problem**
- **Weeds can give insight into soil problems**
- **Knowledge of weed indicators can allow modification of soil management practices**
- **Soils when properly managed will grow better crops and lessen negative influences of weeds**

Typical Pattern of Summer Annual Weeds in a Spring Planted Crop



Many points in the cycle where weeds can be Influenced

Soil factors can influence all of these

Soil Ecology

Soil Ecology dictates ecosystem processes:

1. **Cycling of nutrients**
   - **decomposition**
   - **mineralization**
   - **energy turnover**
2. **Biodiversity – plants, animals, microbes**

The diversity and abundance of live in soil exceeds that of any other ecosystem and can interact to affect weed presence and abundance.

Organic Agriculture

"Alternative strategies for managing plant growth and pest management"

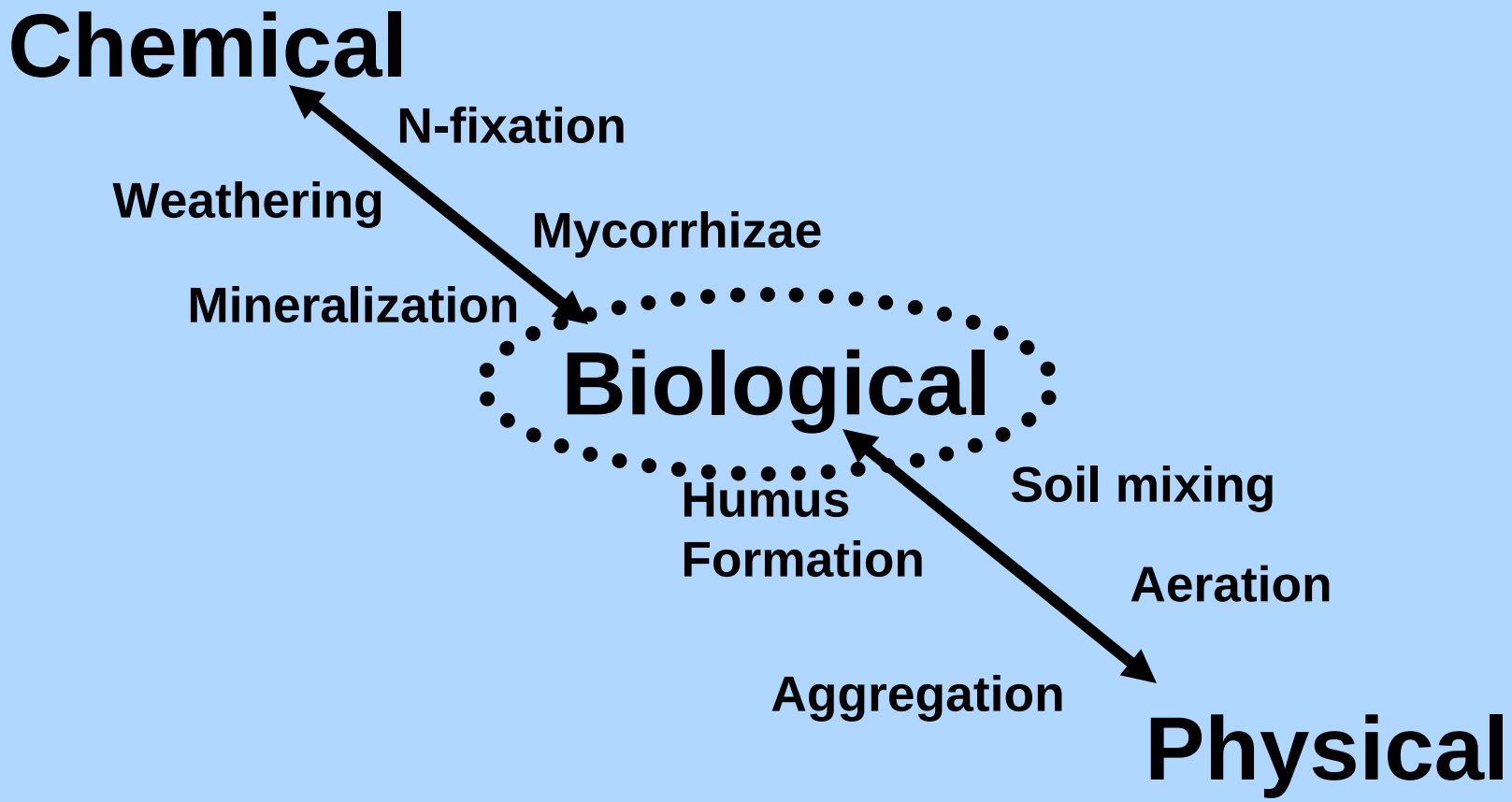
Soil health (Quality) = Plant health

- **Strongly related to soil biology**

- **Soil "Organism"- the Living Soil**
  - **Eats**
  - **Breathes**
  - **Circulates fluids and nutrients**
  - **Reproduces itself**

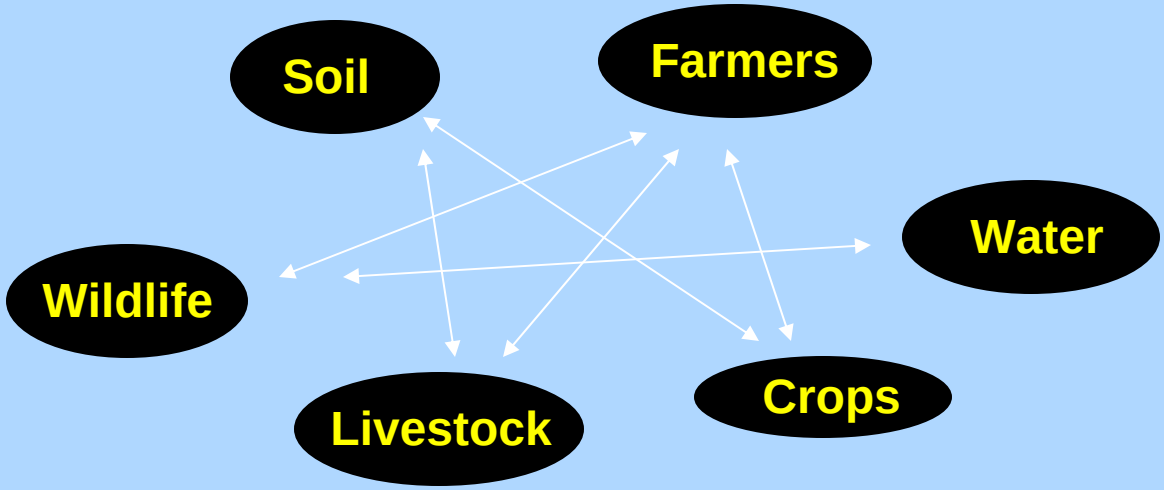
Ecological Perspective:

"Alternative strategies for managing plant growth and Pests."



Ecological Perspective:

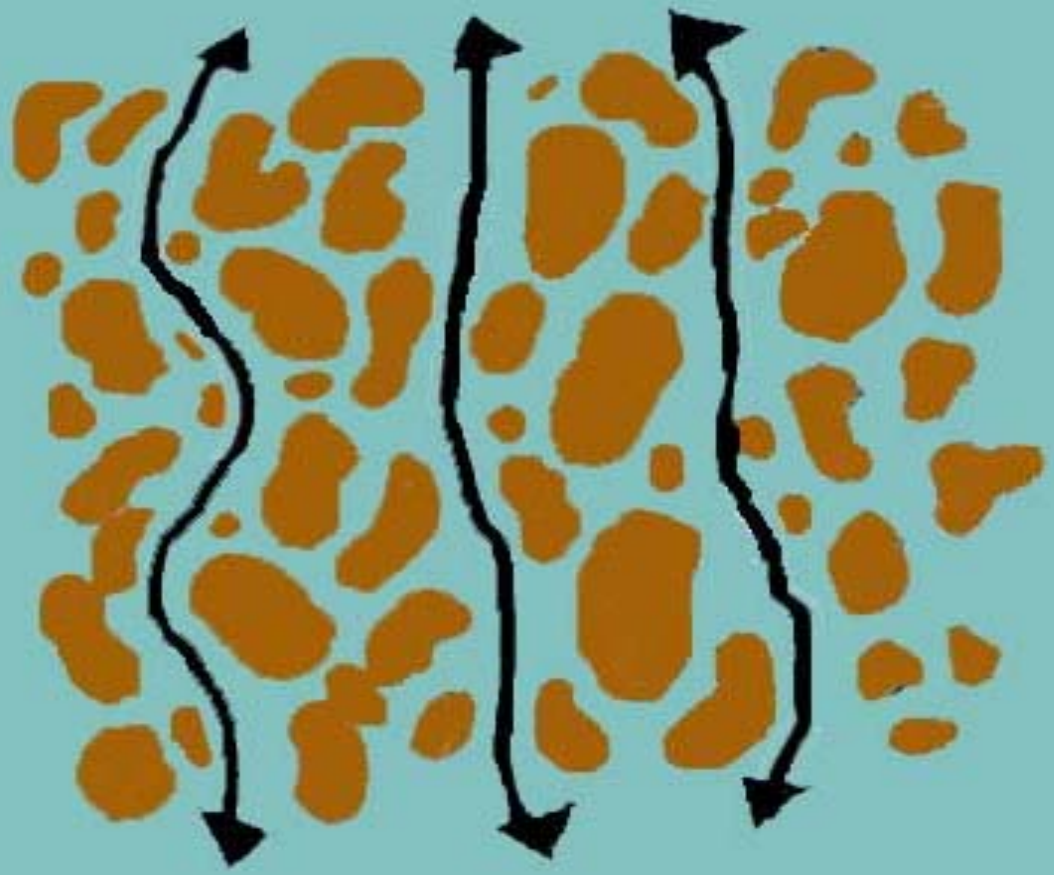
- **Sustainable Agriculture demands a holistic perspective:**



- **Don’t treat the symptoms, manage the cause!**

Characteristics of Good Soil

High Organic Matter



- Good exchange of soil gases
- Good movement of water
- Good tilth for root growth

Features of a “Quality” Soil

- Soft and crumbly, few clods / no hardpan
- Well drained and warms quickly in spring
- Infiltration after heavy rains, little runoff
- Resists erosion and nutrient loss
- High populations of beneficial soil organisms
- High nutrient holding capacity
- Crops respond to low inputs
- High productivity
- Free of harmful contaminants

Platy structure in surface soil resulting from compaction

Poor Soil Quality

- Compacted
- Poor Aeration
- Restricted Root Growth
- Low Nutrient Holding Capacity
- Low Organic Matter
- Lacks Soil Organisms

Soil Factors Important in Weed Management

- Chemical properties
  - Fertility
    - Amount and variation in types
    - Application timing and Placement
  - pH – acidity or alkalinity
  - Allelopathy – presence of plant or microbe produced chemicals that influence plant growth

Fertility

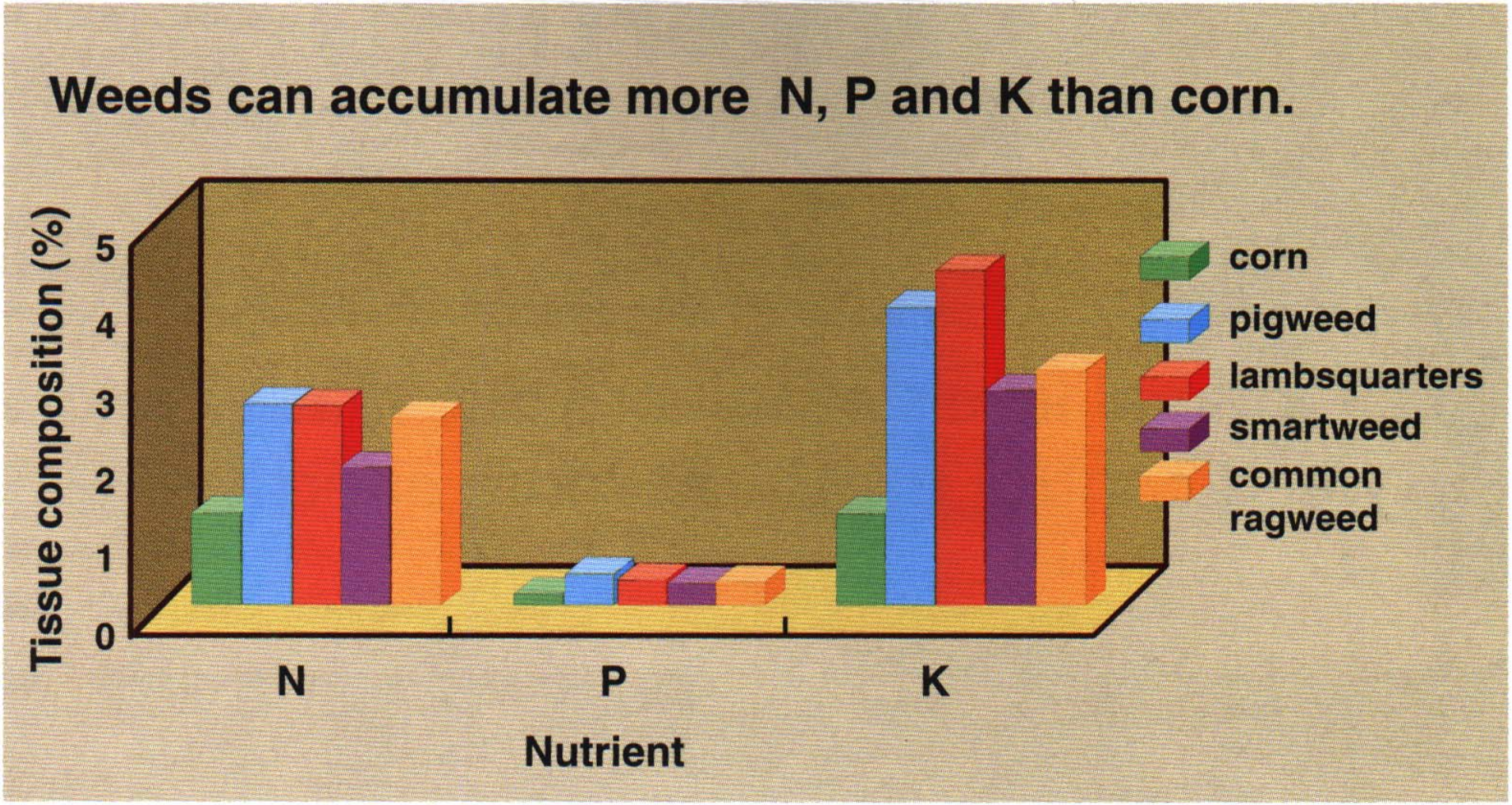


Figure 3. Nutrient concentrations in tissues of common crop and weed species. Source: Vengris et al., 1953.

Fertility

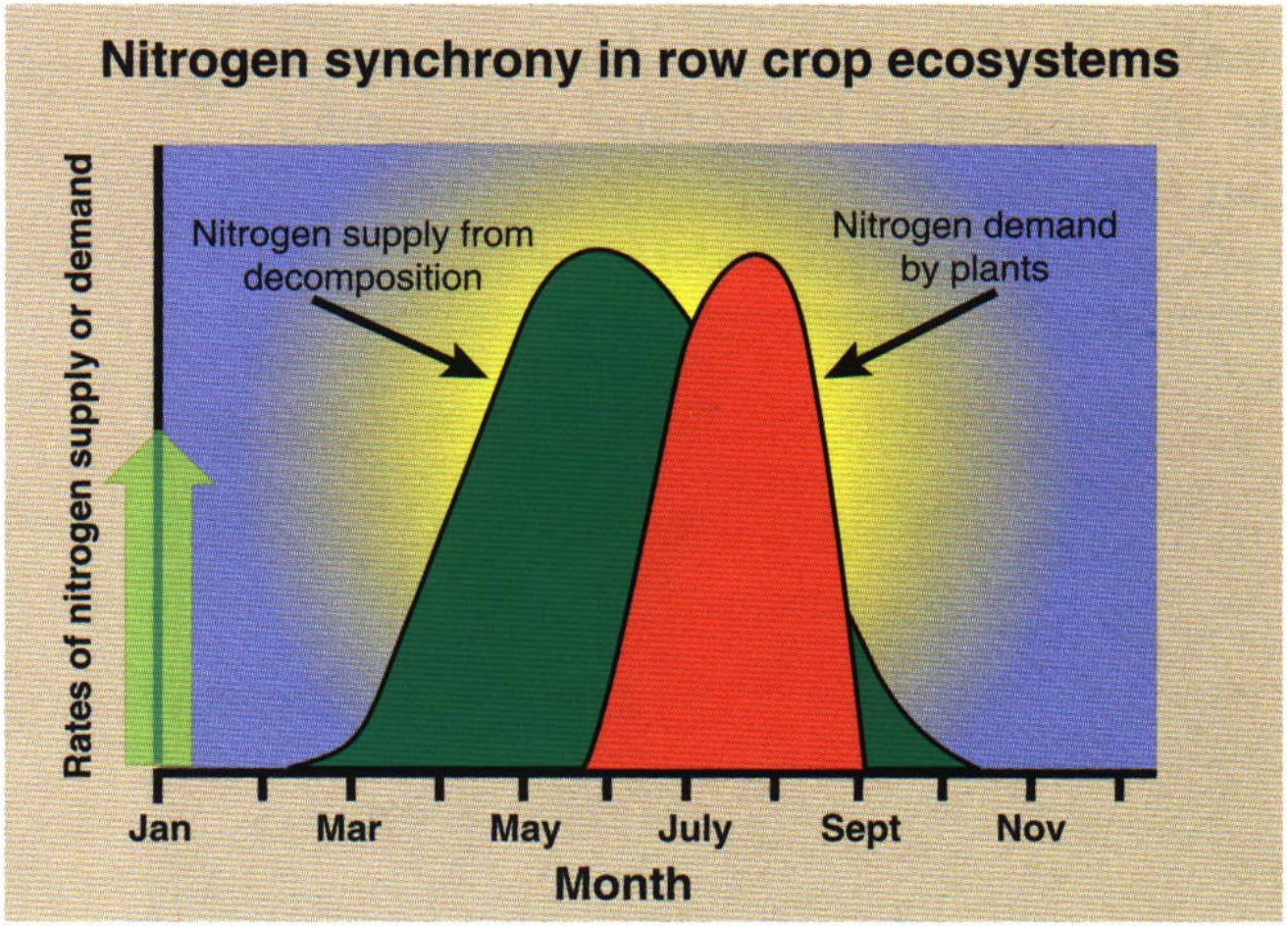


Figure 4. Nitrogen synchrony in row crop ecosystems.
Source: Cavigelli et al., 1998.

Fertility

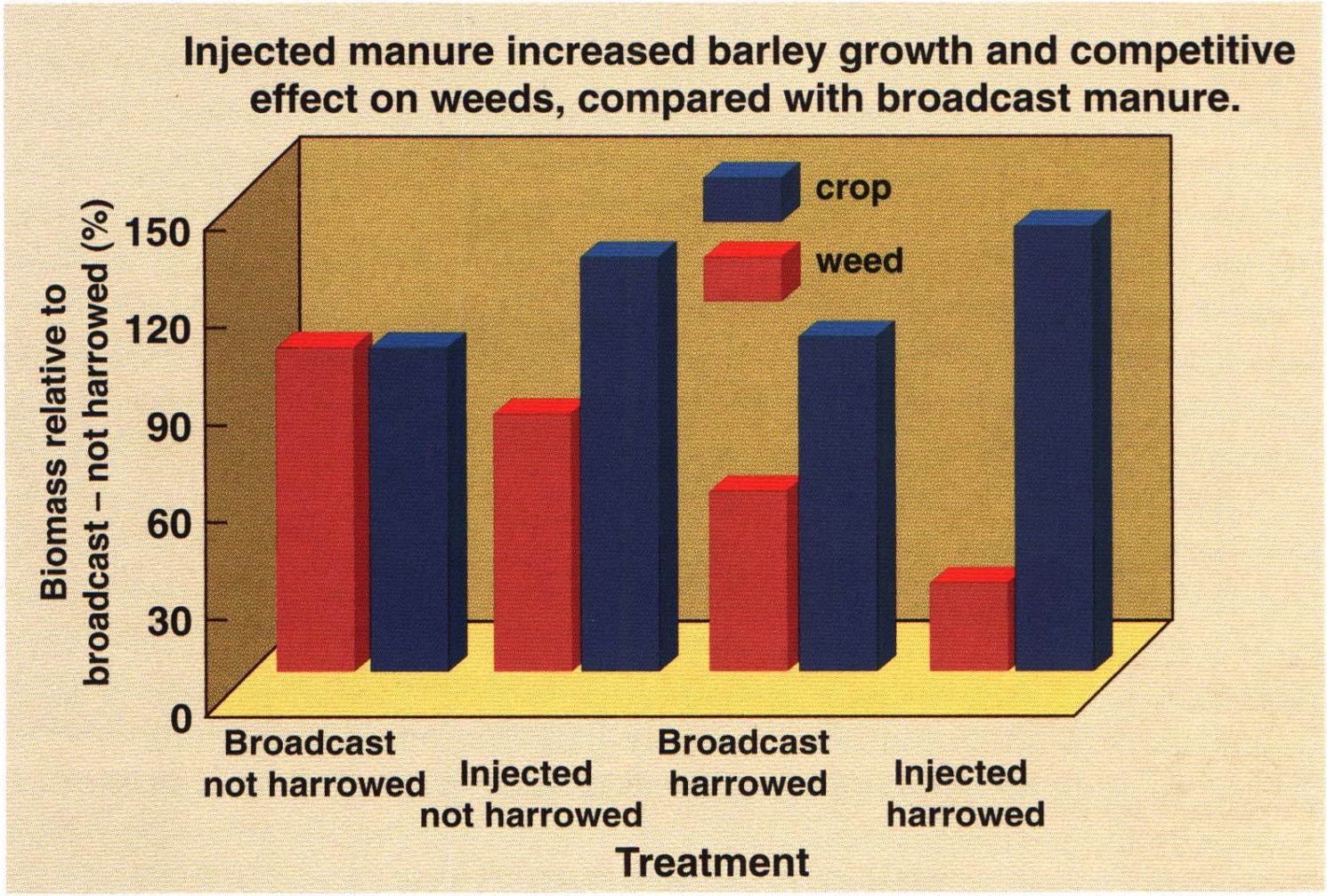


Figure 6. Injected manure increased crop growth and reduced weed biomass compared with broadcast manure. Harrowing was done with a spring-tine harrow. Source: Rasmussen, 2002.

Fertility

- **Give crops the nutrients they need in the right amounts when and where they need them most**
- **Fertilize the crops not the weeds**
- **Fertility allows crops to grow faster than the weeds**
- **Quality soil will help balance nutrient availability – organic matter influence**

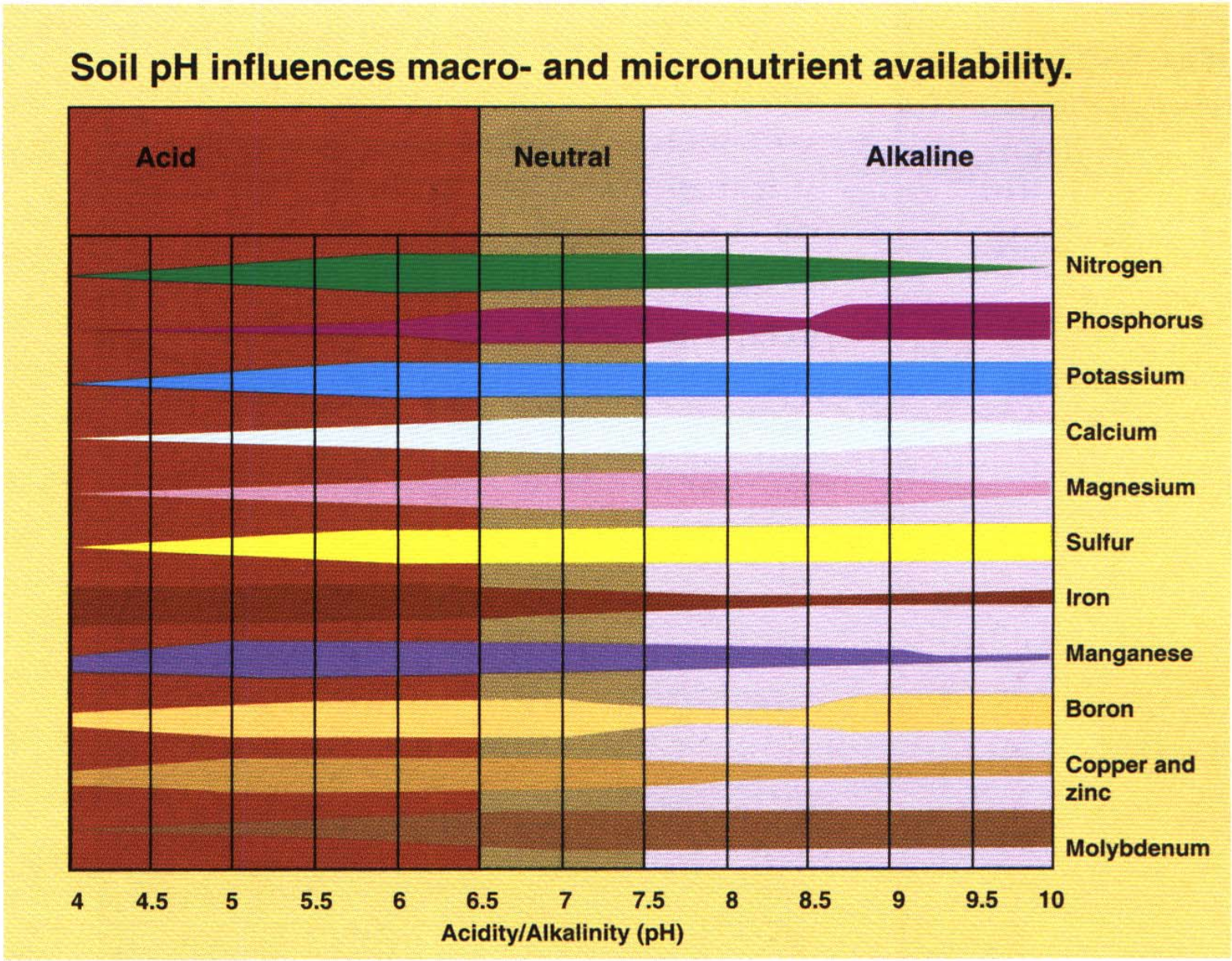


Figure 7. Soil pH influences macro- and micronutrient availability for both crops and weeds. Source: Hoeft et al., 2000.

Soil Factors Important in Weed Management

- Physical properties
  - Composition
    - Sand, silt, clay and organic matter
  - Moisture and water holding capacity
  - Aggregate size
  - Compaction
  - Amount of disturbance

Soil Structure

- **Relates to the clumping or aggregation ability of the soil (sand, silt, clay) into secondary clusters (peds)**

Can be improved or destroyed by choice and timing of agricultural practices


Granular Structure

Angular Blocky Structure

Soil Structure and Seed Germination

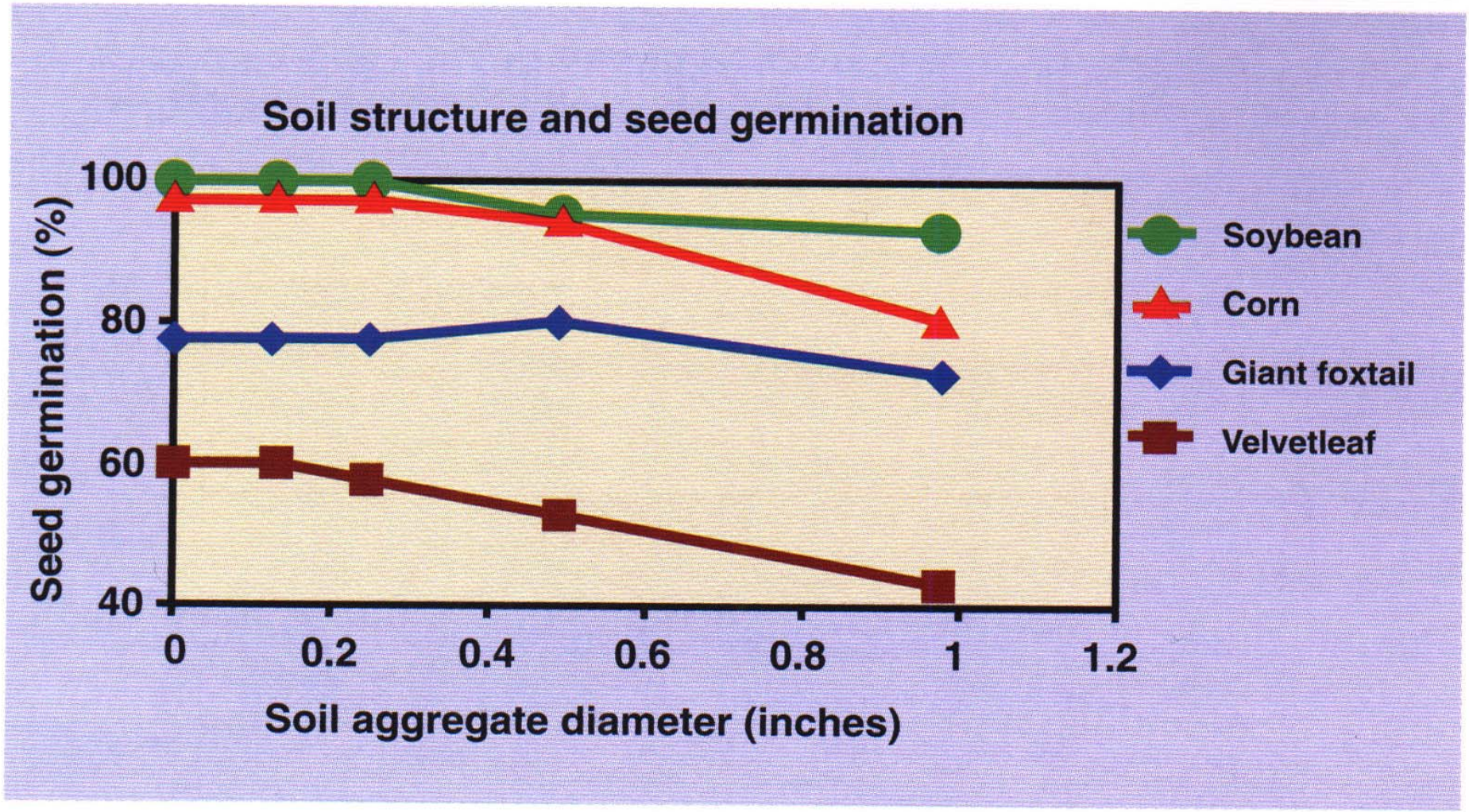


Figure 8. Effect of soil aggregate size on seedling germination. Source: Pareja and Staniforth, 1985.

Compaction

Examples:

Field Bindweed,

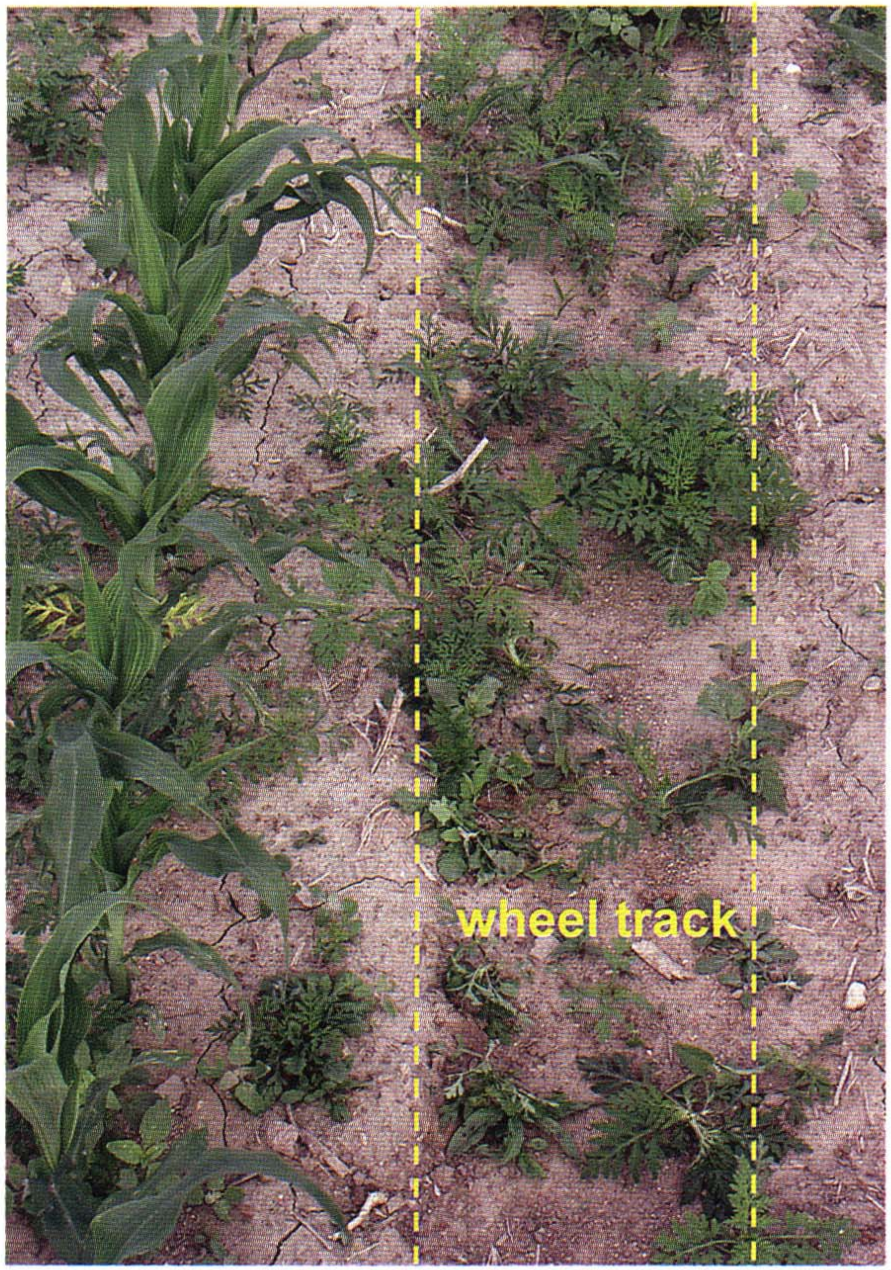
Buttercups,

Chamomile, cinquefoil

Corn marigold,

Quackgrass, mustards

Pennycress



Adam Davis

Figure 9. Weed seedling emergence in a wheel track.

Compaction

Poor Soil Aeration due to Ponded Water

Soybeans are dying due to poor soil aeration.
Southern Tippecanoe Co. 2002

Lack of surface drainage

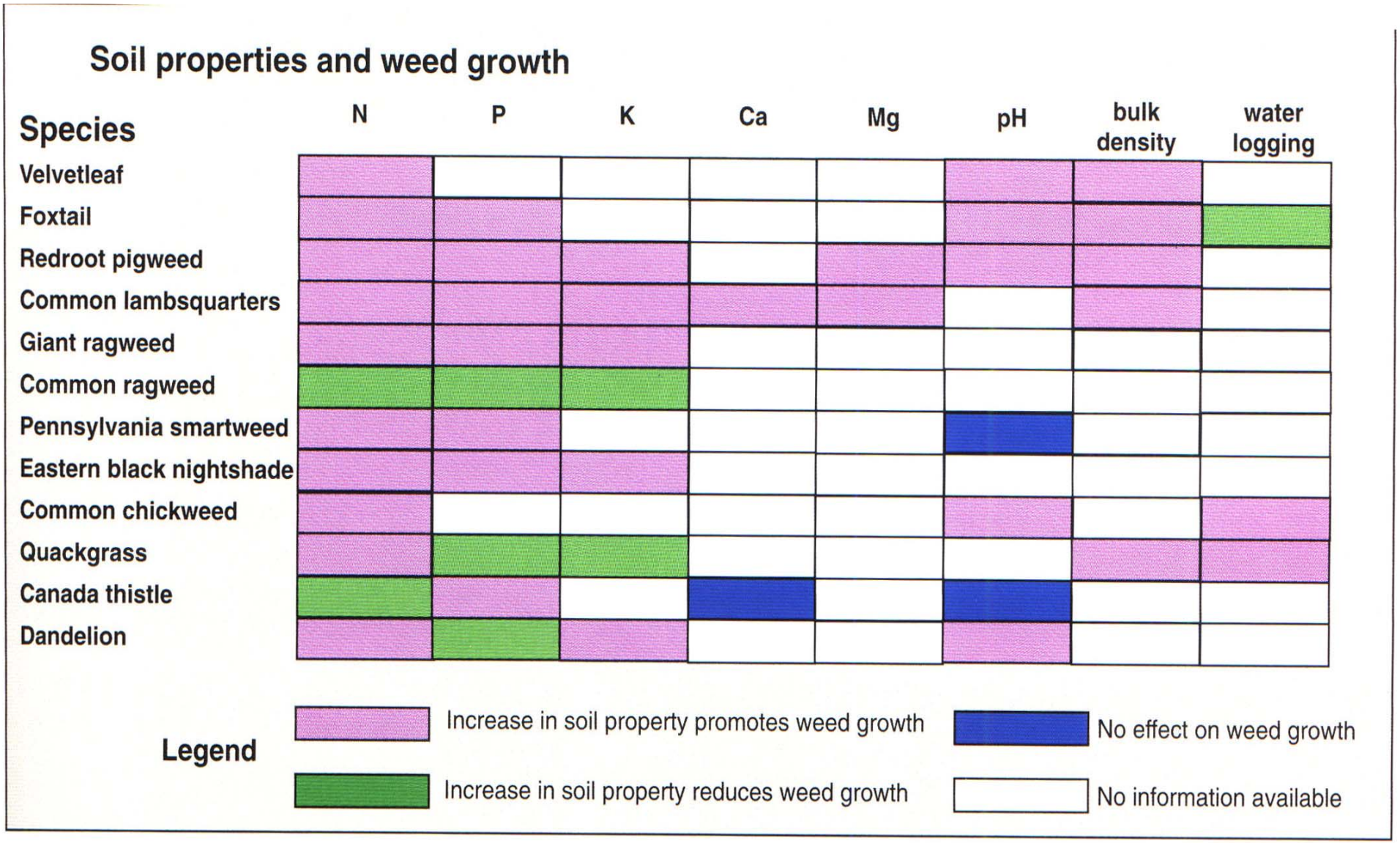


Figure 10. Summary of weed responses to selected soil properties. Sources: Vengris et al., 1953; Lawson and Wiseman, 1979; Bandeen and Bucholtz, 1967; Dieleman et al., 2000; Lindquist, 2001; Tilman, 1999; Jurik and Zhang, 1986; Blackshaw et al., 2002; Salas et al., 1997; Dustman and Shriver, 1931; Collins and Wein, 1988; Cahill and Cooper, 1999; Ugen et al., 2002; Khan et al., 2000; Croster and Masiunas, 1998; Mamolos and Kalburtji, 2001; Tardif and Leroux, 1992; Hakanson and Johnson, 1970; Holm, 1971; Donald, 1994; Buchanan et al., 1975; Weaver and Hamill, 1985; Blackshaw et al., 2003. Blackshaw et al., 2004. For full citation contact Adam Davis. Email: asdavis1@uiuc.edu.

Soil Tilth and Organic Matter

- **Good Tilth = soils that are “friable” with no crusting, excellent water penetration, and good structure**

- **Good physical soil condition impacts:**
  - **Tillage ease**
  - **Seedbed quality**
  - **Seedling emergence ease**
  - **Deep root penetration**
  - **Reduced water runoff**
  - **Increased water holding capacity**
- **All relates to OM/Humus and soil aggregation**

Soil Organic Matter and Humus

- **Organic matter**
  - **Dead organisms**
  - **Plant matter**
  - **Other organic matter in various stages of decomposition**
- **Humus**
  - **Dark colored organic matter in final stages of decomposition - quite stable**
- **Serve as a reservoir of plant nutrients and help build soil structure**

Soil is “Living” not Inert

- View soil as a living organism containing many types of “livestock”
- 1 acre of topsoil can contain:
  - 900 lbs. of earthworms
  - 2,400 lbs. of fungi
  - 1,500 lbs. of bacteria
  - 133 lbs. of protozoa
  - 900 lbs. of arthropods and algae
- They depend on organic matter for food except algae, and all interact to release nutrients, vitamins, amino acids, sugars, antibiotics, gums and waxes.

Soil Factors Important in Weed Management

- **Soil Biological properties**
- **Organisms present in soil or on farm that can affect weeds present and can predate weeds**
  - **Birds**
  - **Mammals**
  - **Earthworms**
  - **Insects**
  - **Microbes**
- **All these organisms are influenced by farming practices**

Soil Microorganisms Functions and Processes

- Decomposition of residues
- Release of plant nutrients
  - Weathering of minerals
  - Carbon dioxide
- Soil humus formation
- Improve soil structure
- N-Fixation
- Mycorrhizal relationships
- Plant pathogens
- Antibiotics produced

Factors Affecting Macro and Micro Population in Soil

- Competition with other organisms
- Nutritional requirements
- Environmental Factors
  - Depth
  - Season
  - pH
  - Moisture
  - Aeration
  - Texture
  - Structure
  - Temperature

Importance of Earthworms

- Mix and aerate soil
- Decompose residues
- Increase nutrient availability
- Improve soil structure
- Increase infiltration of water
- Improve plant growth
- Eat

Soil Arthropods

- **Sowbugs, millipedes, centipedes, slugs, snails, springtails**
- **First decomposers which eat and shred large particles of plant and animal residues, weed seeds**
- **Waste is rich in plant nutrients**
- **Dung beetles - Recycle nutrients from manure, reduce livestock intestinal parasites**

Soil Bacteria

- Make nutrients available for plants
- Release N, S, P, etc. from O.M.
- N fixation, nodulation – Rhizobium
- Solubilize nutrients from minerals - acidifying
- Improve structure – foster aggregation
- Fight root disease (and can cause root disease)
- Detoxify soils
- Smell of soil - (actinomycetes)

Soil Fungi

- Quick colonization and breakdown of O.M.
- Release nutrients from soil minerals
- Release hormones and antibiotics
- Predators
- Colonize roots - mycorrhizae
  - Aid in nutrient – water capture
  - Aid in P uptake

Benefits of a “Healthy” Soil

- **Balance of C and N and soil organisms leads to:**
  - **Rapid residue decomposition**
  - **Granulation of soil into water stable aggregates**
    - **Reduced erosion potential**
  - **Decreased crusting and clodding**
    - **Improved crop emergence and root growth/penetration**
  - **Better water infiltration**
  - **Improved internal drainage**
  - **Increased water and nutrient holding**
  - **Easier tillage and crop harvesting especially root crops**

Sustainable Soil Management Practices

- Soil organisms cycle nutrients and provide many other benefits
- OM is the food for heterotrophic soil organisms
- Soil should be covered to protect it from erosion and temperature extremes
- Tillage speeds the decomposition of OM – beneficial ???
- C:N ratio will effect rate of OM utilization and or decomposition (> 25 /1 temporarily ties up N)
- Plowing can have + or - effects
- OM increases occur if additions exceed decomposition
- Soil fertility levels must be monitored and amended as needed using manures, green cover crops, compost, and mineral additives.

Weed Management Strategies Build on Quality Soil Management

- **Proper Soil Management to best match crop demands to detriment of weeds**
- **Build good soil structure by using soil organic amendments, cover crops, catch crops and avoid tilling wet soils**
- **Reduce weed seedling emergence by avoiding soil compaction**
- **Use allelopathy from cover crops**

Weeds Common in Wet sites and Poorly Drained Soils

- **Alligatorweed**
- **Annual bluegrass**
- **Sedges**
- **Barnyardgrass**
- **Bittercress**
- **Liverworts**
- **Moneywort**
- **Mosses,**
- **Pennywort**
- **Virginia buttonweed,**
- **Improve tilth and drainage**

Weeds Common in Compacted Soil

- Annual bluegrass
- Annual sedge
- Broadleaf plantain
- Speedwell
- Goosegrass
- Lespedeza
- Prostrate knotweed
- Spotted spurge

Weeds Common in Drought-Prone Soils

- Bitter sneezeweed
- Black medic
- Broomsedge
- Goosegrass
- Lespedeza
- Prostrate knotweed
- Spotted knapweed
- Spotted spurge
- Yellow woodsorrel

Weeds found in Sites with High or low Soil Nitrogen

- **High N**
  - **Annual bluegrass**
  - **Common chickweed**
- **Low N**
  - **Birdsfoot trefoil**
  - **Black medic**
  - **Broomsedge**
  - **Corn Speedwell**
  - **Hawkweed**
  - **White clover**

Weeds found in Acidic Soils

- **Broomsedge**
- **Mosses**
- **Red sorrel**

Weeds found in Shady Areas

- Ground ivy
- Japanese stiltgrass
- Poison ivy
- Violets
- Virginia Creeper

Questions

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