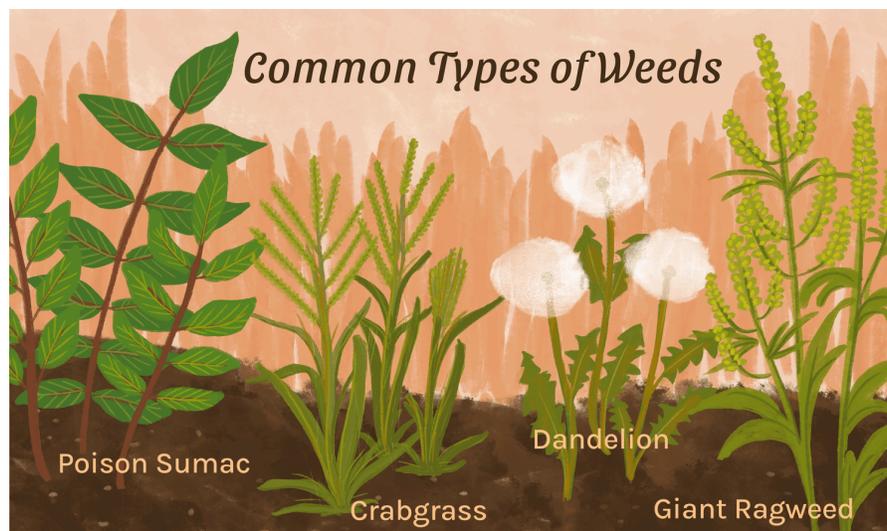


Chapter 4. Competition and identification of weeds

4.1. General information on the biology and harmfulness of weeds

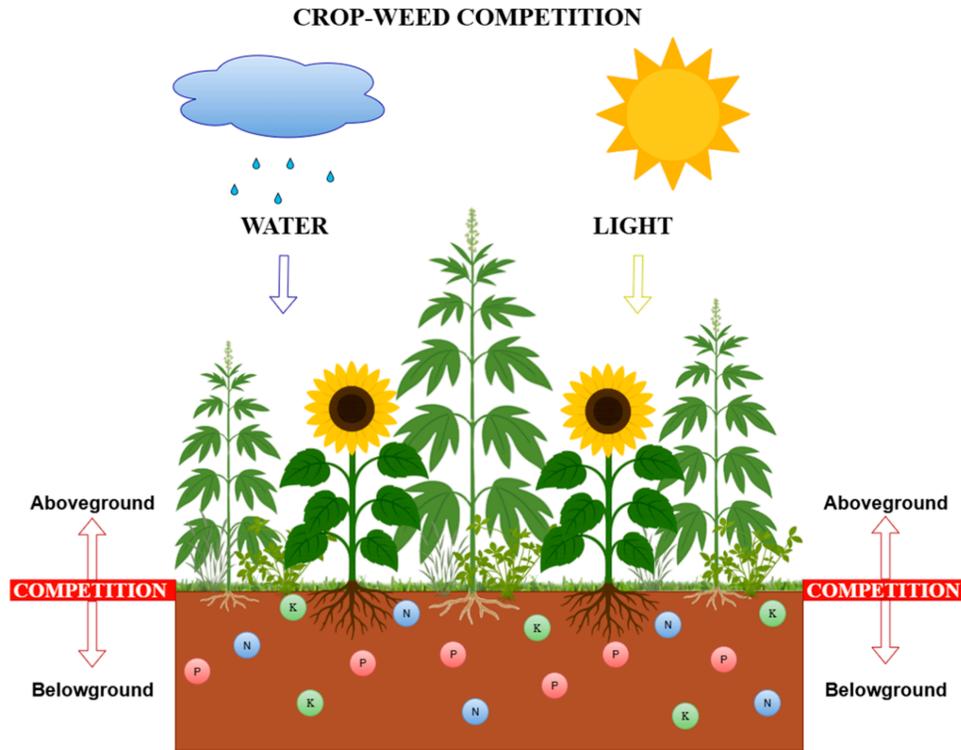
A weed is a plant considered undesirable in a specific situation, growing where it conflicts with human goals. In agriculture, this conflict is direct, as the primary reason for controlling weeds is to protect crop yields from their negative effects. The harm caused by weeds extends beyond simple competition, encompassing a complex syndrome of direct resource competition, non-competitive antagonism, and indirect damage.



4.1.1. The Multifaceted Nature of Weed Harmfulness

Weed interference, a multi-faceted challenge in crop production, occurs when species compete for limited resources. This competition manifests through various mechanisms, primarily direct harm via above and below-ground competitive interactions.

- **Aboveground Competition (Light & Space):** Plants compete for light by occupying canopy volume. Taller plants gain a competitive edge by intercepting more sunlight, as light cannot be stored. Rapid vertical growth is therefore advantageous.
- **Belowground Competition (Water & Nutrients):** Weeds and crops compete directly for limited soil moisture and essential nutrients (e.g., nitrogen, phosphorus, potassium). It is generally assumed that belowground competition is decisive when nutrients are limited, while light competition dominates in fertile, dense stands.



Direct Harm: Non-Competitive Antagonism (Allelopathy) Distinct from resource competition, **allelopathy** is a form of "chemical warfare" where a plant releases organic molecules (allelochemicals) into the environment that can inhibit the growth of neighboring plants.

The effect depends on the chemical type, its concentration, and the crop's susceptibility. Research indicates allelochemicals can act at the molecular level, inducing changes in gene expression in the receiver crop plant.

4.1.2. Indirect Harmfulness and Economic Impacts

Weeds cause economic damage not only through direct yield loss but also by acting as hosts for other pests and by interfering with farming practices.

Weeds found in and around fields can act as hosts for various crop pests, including insects and nematodes, as well as pathogens like fungi and viruses.

- Alternative hosts (same family as crop) help a pest survive when the primary crop is absent.
- Alternate hosts (different family) may be required for a pest to complete its life cycle.

For example, wild mustard species can harbor aphids, and viruses like bean golden yellow mosaic virus can survive in weed hosts. A dense weed stand also promotes fungal diseases by restricting air circulation and prolonging leaf wetness.

Weeds significantly impede agricultural operations, leading to increased expenses. For example, in lettuce cultivation, a weedy field complicates and raises the cost of the thinning process. During harvest, dense weed infestations can render mechanical harvesting inefficient or even impossible. Furthermore, weeds can obstruct irrigation and drainage systems.

4.1.3. Fundamental Weed Biology: Strategies for Persistence

The success of weeds is rooted in their robust biological strategies for reproduction, dispersal, and long-term survival. These strategies allow weeds to persist across time and space, making their management a perpetual challenge.

Reproductive Strategies: Weeds employ two primary methods of reproduction:

1. Sexual Reproduction (Seed):

For weeds that only live a year or two (annuals and biennials), making seeds is their only way to multiply, and for weeds that live longer (perennials), it's one of their main ways to spread.

Weeds are massive seed producers, where a single curly dock plant can drop over 30,000 seeds.

This strategy helps weeds spread out in two ways:

- Across space (scattering them far and wide).
- Across time (seeds can lie dormant, or "asleep," and wait until the conditions are perfect to sprout).

2. Asexual (Vegetative) Propagation:

This is the hallmark of perennial weeds. They reproduce using specialized vegetative structures, including rhizomes, stolons, tubers, and creeping roots. Dormant buds on these underground parts allow them to rapidly recover from disturbance (like tillage) and to multiply if fragmented.

The Role of Seed Dormancy in Weed Survival Seed dormancy is the primary mechanism for dispersal in time, a "resting stage" where seeds are alive but not germinated. This strategy is crucial for survival, allowing seeds to avoid unfavorable conditions (like winter or herbicides) and germinate later in "flushes" over many years, making eradication almost impossible. Dormancy is regulated by:

- Physical factors: Impermeable or mechanically resistant seed coats.
- Physiological factors: The seed may contain an immature embryo or require a period of "after-ripening."
- Environmental Triggers: Germination is often cued by specific environmental conditions, including temperature, moisture, oxygen levels, and light.

4.2. Classification and identification of weeds

4.2.1. Systems of Weed Classification

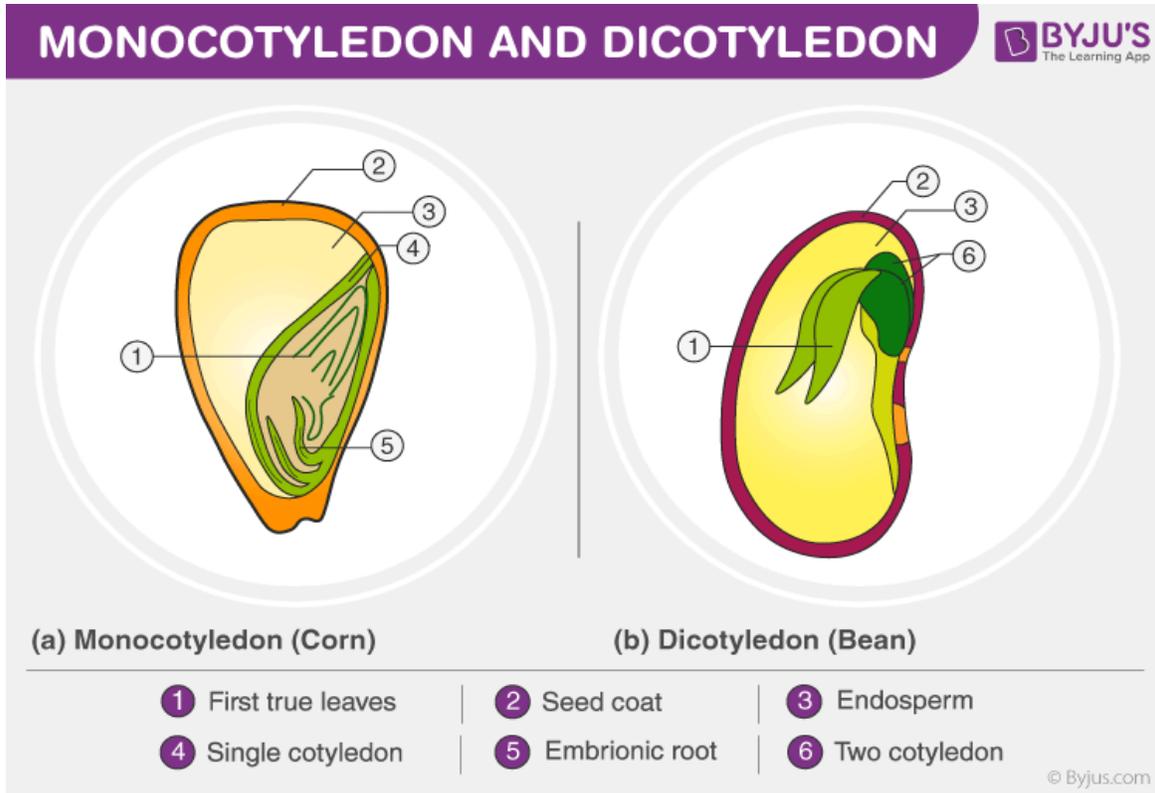
While the term "weed" has no true botanical significance, a plant is only a weed in the context of human objectives, weedy plants can be categorized using several functional systems.

4.2.1.1. Classification by Life Cycle: This system groups weeds by their lifespan and has a "profound impact" on the selection and timing of control measures.

- **Annuals:** Complete their entire life cycle, from seed to seed, within one year or a single growing season. They reproduce only by seed.
 - **Summer Annuals:** Germinate in the spring, grow through the summer, produce seed, and die in the fall (e.g., *Amaranthus retroflexus*, or Redroot Pigweed).
 - **Winter Annuals:** Germinate in the fall, overwinter as a small plant, then resume growth, flower, set seed in the spring, and die in the early summer (e.g., downy brome).
- **Biennials:** Complete their life cycle over two growing seasons. In the first year, they germinate and form a vegetative rosette and a storage taproot. In the second year, the plant "bolts," sending up a flowering stalk, sets seed, and then dies. Examples include wild carrot and common mullein. This life cycle is only exhibited by broadleaf weeds.
- **Perennials:** Live for more than two years, regrowing each season.
 - **Simple Perennials:** Reproduce primarily by seed but can regrow from a strong taproot if cut (e.g., dandelion).
 - **Creeping Perennials:** The most difficult to control, they reproduce by seed and by vegetative structures such as rhizomes (e.g., Canada thistle) or tubers.

4.2.1.2. Botanical Classification: The Monocot vs. Dicot Divide This is the fundamental botanical division of flowering plants and is the basis for modern selective herbicide technology.

- **Monocotyledons (Monocots):** Emerge from the soil with a single seed leaf (cotyledon). Key characteristics include leaves with parallel veins, flower parts in multiples of three, and a fibrous root system. This group includes grasses and sedges.
- **Dicotyledons (Dicots):** Emerge with two seed leaves (cotyledons). Key characteristics include leaves with netted or branched veins, flower parts in multiples of four or five, and typically a taproot system. This group includes most of the plants referred to as "broadleaf" weeds.



4.2.1.3. Agronomic (Morphological) Classification: This is the most common and practical system, grouping plants by their general appearance: Grasses (monocots, family Poaceae) , Sedges (monocots, family Cyperaceae) , and Broadleaf Weeds (dicots).

4.2.2. Morphological Identification of Weed Groups

Distinguishing between the three agronomic groups is the first step in identification. A common saying used for field identification is "Sedges have edges, rushes are round, and grasses have joints (nodes)."

- **4.2.2.1. Grasses** (e.g., *Echinochloa crus-galli*):
 - Stems: Stems (culms) are usually hollow and are round or flattened in cross-section.
 - Leaves: Leaves are narrow with parallel veins. They are arranged in two "ranks," meaning they emerge in sets of two, one on each side of the stem.



- **4.2.2.2. Sedges** (e.g., *Cyperus rotundus*):
 - Stems: This is the key identifier. Stems are solid (not hollow) and are distinctly triangular in cross-section.
 - Leaves: Leaves are narrow with parallel veins. They are arranged in three "ranks," emerging in sets of three from the stem.



- **4.2.2.3. Broadleaf Weeds** (e.g., *Amaranthus palmeri*):
 - Stems: Stems are usually solid and can be round, square, or variable in shape.
 - Leaves: Leaves are wide and feature netted or branched veins.
 - Roots: Typically a taproot system.

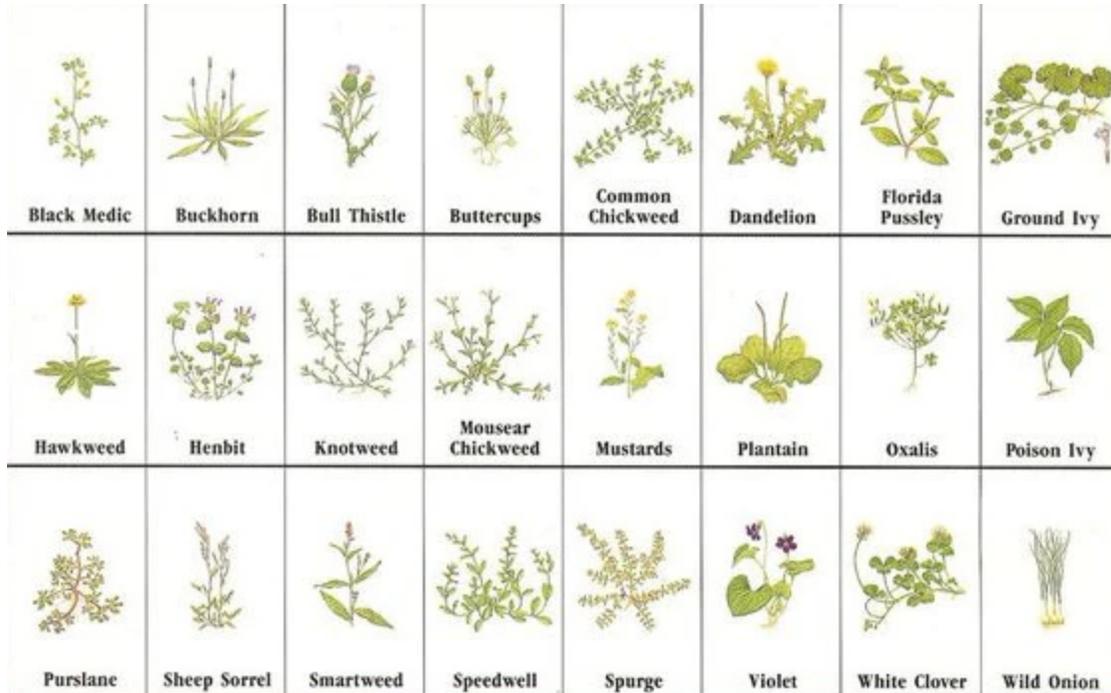


Table 4.1. Morphological Comparison of Major Weed Groups

Feature	Broadleaf Weeds (Dicots)	Grasses (Monocots)	Sedges (Monocots)
Seedling (Cotyledons)	Two seed leaves	One seed leaf	One seed leaf
Stem (Cross-Section)	Usually solid; variable shape (round, square)	Hollow and round, or flattened	Solid and triangular
Leaf Veins	Netted or branched	Parallel	Parallel
Leaf Arrangement	Variable (opposite, alternate)	2-ranked (in sets of 2)	3-ranked (in sets of 3)
Root System	Typically a taproot	Fibrous	Fibrous, often with rhizomes or tubers
Flowers	Often showy; parts in 4s (4 petals and 4 sepals) or 5s (5 petals and 5 sepals)	Not showy; small (florets)	Not showy; spikelets

4.3. Cultural factors favoring weed development

The specific weed community found in a field is not accidental. Instead, it is a direct consequence of ecological selection influenced by agricultural management. Agronomic choices, such as tillage, crop rotation, and fertilization, act as strong "ecological filters." These filters create a particular environment that favors weeds with life cycles and characteristics ideally suited to that system.

4.3.1. Tillage and Soil Disturbance

Tillage is one of the most significant filters. It is used to prepare seedbeds and manage residues, but it also fundamentally alters the soil's physical properties and, critically, changes the vertical distribution of the soil weed seedbank.

- **Conventional Tillage (e.g., Moldboard Plowing):** This agricultural method inverts the soil, burying recently deposited seeds and exposing dormant ones to the surface. This disruption, including light exposure, effectively breaks the dormancy of numerous annual seeds. While beneficial for controlling perennials, it inadvertently creates optimal germination conditions for annual weeds like Redroot Pigweed and Wild Mustard, which flourish in disturbed environments.
- **Zero Tillage (No-Till):** Seeds are planted directly into undisturbed residue, leaving weed seeds near the surface. The loss of tillage as a control method is the dominant selective force. This system strongly favors Perennials (like Canada thistle and quackgrass), as their underground root systems are not disturbed, and also Winter annuals.

4.3.2. Cropping Systems and Temporal Diversity

The choice of which crops to plant, and in what sequence, is another powerful ecological filter.

- **Monoculture Systems:** Continuous monocropping (e.g., corn) favors weeds that mimic the crop and resist limited herbicides. This leads to low weed diversity but high densities of dominant species, accelerating herbicide resistance.
- **Crop Rotation:** Crop rotation is key to cultural weed control. It destabilizes the weed environment by varying competition, allelopathy, timing, and tillage, preventing any single weed from dominating. Perennial forages or winter small grains are more disruptive than alternating two summer annuals.

4.3.3. Fertility and Irrigation Management

Nutrient Application Rate and Placement High fertilization rates, particularly with nitrogen, can increase weed competitiveness, as many weeds are highly responsive to nutrients. However, where fertilizer is placed is critical.

4.3.3.1. Broadcast Applications

- What it is: Spreading fertilizer evenly on the soil surface (topdressing) or mixing it slightly into the topsoil (incorporation).
- Effect: Nutrients are available everywhere, so both the crop and shallow-germinating weeds can access them.
- Implication: Good for general nutrient availability, but can help weeds grow if they germinate near the surface.

4.3.3.2. Strategic Placement

- What it is: Placing fertilizer in specific spots:
 - Banding: a concentrated line near the seed but below its depth.
 - Dibbling: putting fertilizer in small holes near the plant.
 - Subdressing: placing fertilizer deeper than shallow seedlings can reach.
- Effect: Nutrients go directly to crop roots, especially established or deeper roots, and are less available to shallow weed seedlings.
- Implication: Helps feed the crop efficiently while reducing weed growth near the surface.

4.4. Examples of harmful weeds

The biological principles of persistence and the selective pressures of cultural practices culminate in the specific weed problems seen in the field. While some weeds are globally notorious for their "weedy" traits, all weed ecology is ultimately local.

4.4.1. Profiles of Globally Significant Agricultural Weeds

The "world's worst weeds" are typically species that have perfected one or more of the persistence strategies.

- Purple Nutsedge (*Cyperus rotundus*): Considered one of the world's most problematic weeds, this perennial sedge reproduces almost exclusively via a vast underground network of tubers that grow in chains. Its many dormant tubers make it "essentially futile" to control with tillage.
- Barnyardgrass (*Echinochloa crus-galli*): A major global weed, it is especially problematic in rice. Its success comes from being an ecological mimic of rice, as it thrives in the same wet, high-nitrogen soils and can even germinate in flooded conditions.
- Palmer Amaranth (*Amaranthus palmeri*): An aggressive annual broadleaf weed, it is defined by a combination of devastating traits: extremely rapid growth (2-3 inches per

day), prolific seed production (100,000 to over 500,000 seeds per plant), and a dioecious (male/female plants) nature that forces outcrossing, leading to high genetic diversity and rapid evolution of herbicide resistance .

4.4.2. Regional Case Study: Weed Flora in Skikda, Algeria

While global weeds demonstrate key principles, all weed ecology is local. Studies in the Skikda region of Algeria illustrate this. An inventory of potato crops found a high diversity of 90 weed species, dominated by annuals, with 16 species identified as potentially noxious . A separate study in citrus groves showed how climate acts as a filter, with different weed species selectively dominating the humid northern part of the region versus the dry southern part.