Weed Classification and Life History

Liebman et al. (2001)
Radosevich et al. (2007)

Objectives:

Students review/learn common weed nomenclature.
Student gain knowledge of weed life history that will be used to guide their understanding of how weed management works and how it can be improved.

Weed Nomenclature

Broadleaf, grasses, and sedges

Dicotyledons - broadleaf weeds

- Seedlings that produce 2 cotyledons/seed leaves.
- Leaves with netted venation
- Flowering parts in fours, fives or multiples of fours and fives.
- Ex. Mustards (*Brassica* spp.), nightshades (*Solanum* spp.), morningglory (*Convolvulus* spp.)

Monocotyledons - grasses and sedges

- Seedlings bear one cotyledon
- Parallel leaf venation
- Flower parts in threes or multiples of threes
- Most weeds are either grasses (Poaceae) or sedges (Cyperaceae)
- Other important monocot families are the palm family (Arecaceae), banana family (Musaceae), ginger family (Zingiberaceae), the onion family (Alliaceae), and Orchidaceae

  Grasses: Species belonging to the Poaceae family.

  Sedges: Species belong to the Cyperaceae family.

Figure 2.1. Ecological characteristics of agricultural weeds.

Weeds have some common characteristics that adapt them to life in agroecosystems.

Weed characteristics that favor establishment

- Germination and emergence over a range of environmental conditions.
- Rapid growth.
- Highly competitive for nutrients and water.
- Mature plants tolerate a wide range of environmental conditions.

Weed characteristics that favor establishment

- Self-fertilize or reproduce vegetatively.
- Abundant and continual seed production under favorable conditions.
- Polymorphic seeds.
- Seeds resistant to animal digestion.
- Prolonged seed viability; dormancy.

Life history: refers to the length of the life cycle, season of growth, and method of reproduction.

The ecologically distinct types of weed species are adapted to different stages of ecological succession.

Annuals:

- Life cycle from seed to seed is completed in 1 year or less.
- Largest weed category.
- Seeds generally persist in the soil for many years, some for decades.
- Two groups: summer and winter annuals depending on the time of germination, maturation, and death.
  Winter annuals – germinate in the fall or winter, grow through out the spring, set seed and die by early summer.
  Summer annuals – Germinate in spring, grow throughout the summer, set seed by autumn and die before winter.

In mild climates – some winter annuals germinate in late summer or autumn and some summer annuals live throughout the winter.

- Annuals predominate following severe disturbances like tillage.
- They survive as seeds in a physiologically dormant state.

Fig. 1.2 from Radosevich et al. (2007)

Biennials:

- Live longer than 1 year but less than 2.
- In the first growth phase the seedling develops into a rosette. Can be confused with winter annuals because of this growth habit.
- Like annuals they reproduce only by seed.
- After a cold period vegetative resumes followed by floral initiation, seed production and death. (Bolting)
- Often large plants when they mature and have thick fleshy roots. *Daucus carota*

Perennials:

- Plants that live for more than 2 years and may reproduce several times before dying.
- Generally produce new vegetative growth year after year from the same root system.

(1) Stationary herbaceous perennials – Reproduce almost exclusively from seed and normally does not reproduce vegetatively. However if the root system is injured or cut, each piece can regenerate into another plant. Eg Dandelion (*Taraxacum officianale*). Eventually die because they do not rejuvenate vegetatively. Seeds may persist in the soil for several years. Most are broadleaf species. Stationary perennials (like annuals) also are adapted to establishment shortly after tillage. However their seedling growth rate tends to be slower because they allocate more resources to root growth. This gives them a greater advantage in the second season compared with germinating annuals in perennial crops. Common in hay fields for example.

(2) Creeping or wandering herbaceous perennials – Survive over the winter and produce new vegetative structures (ramets) from asexual reproductive organs such as rhizomes, tubers, stolons, bulbs, corms, and roots. Life span of a genetic individual is indefinite and potentially very long. Most reproduction occurs vegetatively, but they also reproduce sexually from seed (genets). Seeds may persist for more than one year, but are generally not long-lived so are not well-represented in the seed bank. For creeping or wandering perennials tillage separates daughter plants from the parents and disperses them across fields and to other fields. Tillage also removes the existing vegetation that would compete with the weeds. Thrive under moderate tillage but they are typically susceptible to deep and frequent tillage.

(3) Woody perennials – plant stems have secondary growth, producing wood and bark resulting in an incremental increase in stem diameter each year. Eg trees, shrubs, and many vines. Most reproduce by seed that is short lived. Problems primarily in perennial cropping systems like orchards, and permanent pasture, and increasingly a problem in no-till annual crops - long lifespan, tall stature, vigorous resprouting after cutting and browsing. Poorly adapted to cropping systems with annual tillage: only a few of these species form persistent seed banks. Woody plants have a slow rate of growth compared with herbaceous plants, so they are generally not very competitive with herbaceous annual crops.

Ecological Characteristics of Agricultural Weeds and Crops (Table 2.1)

An understanding of life history characteristics can provide insights into how weed management practices work and how they can be improved. Weeds can differ in the following ways:

- Longevity or life span
- Ability to spread vegetatively
- Seed persistence in soil
- Season of germination

Life history influences which weeds will occur in particular cropping systems and the effectiveness of control measures.

Liebman et al. (2001)

Table 2.1. *Ecological characteristics of agricultural weeds and crops*

Character	Weed	Crop
Maximum relative growth rate (g $g^{1}d^{1}$)	Very high	High
Early growth rate (g d^{1})	Low	High
Shade tolerance	Low	Low
Tolerance of nutrient stress	Low	Low
Nutrient uptake rate	Very high	High
Seed size	Mostly small	Mostly large
Size at establishment	Mostly small	Mostly large
Reproductive rate	High	Varies with crop
Seasonal innate seed dormancy	Frequent	Very rare
Germination in response to tillage related cues[a]	Common	Rare
Seed longevity in soil	Often long	Usually short
Dispersal	Mostly by humans	By humans

Notes: [a] Light, fluctuating temperature, nitrate.

Radosevich et al. (2007)

TABLE 5.5 Types, Causes, and Characteristics of Seed Dormancy

Type	Cause(s) of Dormancy	Characteristics of Embryo
Physiological	Physiological inhibiting mechanism of germination in embryo	Fully developed, dormant
Physical	Seed coat impermeable to water	Fully developed, nondormant
Combinational	Impermeable seed coat; physiological inhibiting mechanism of germination in embryo	Fully developed, dormant
Morphological	Underdeveloped embryo	Underdeveloped, nondormant
Morphophysiological	Underdeveloped embryo; physiological inhibiting mechanism of germination in embryo	Underdeveloped, dormant

Source: Baskin and Baskin (1989), in Allessio-Leck et al. (1989). *Ecology of Soil Seed Banks*. Copyright 1989 with permission from Elsevier.

Booth et al. (2010)

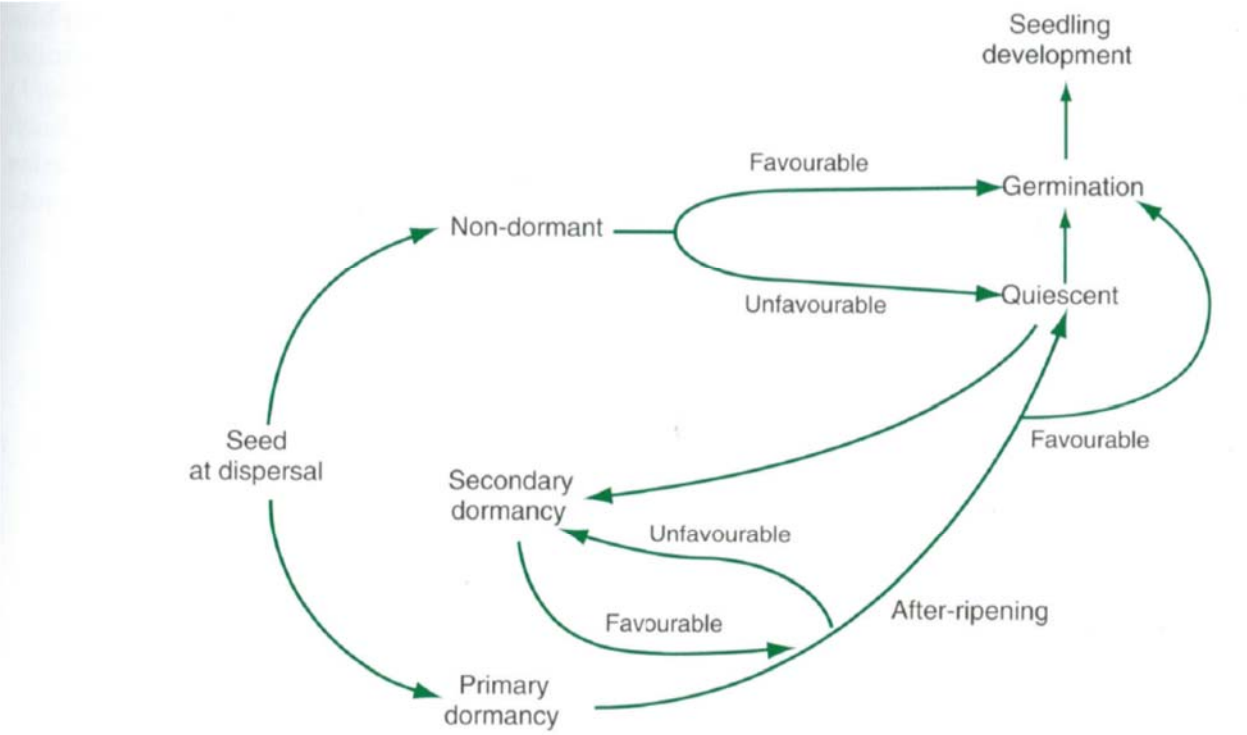


Fig. 6.5. The fate of a seed from when it disperses to when it germinates (Foley, 2001).

Table 6.2. Definitions of terms associated with seed dormancy (see also Fig. 6.5).

Term	Definition
After-ripening	A physiological process whereby an embryo gradually matures and is able to germinate over a broader range of conditions.
Dormant	Seeds unable to germinate even though they have imbibed water and are under favourable environmental conditions.
Non-dormant	Being able to germinate under favourable environmental conditions.
Primary dormancy	Seeds that are unable to germinate when they mature and are either dispersed or still attached to the maternal parent plant.
Quiescent	Seeds that are unable to germinate owing to unfavourable environmental conditions.
Secondary dormancy	Dormancy that is imposed on the seed after being dispersed.

Table 2.2. *Four types of weed life-history strategies*

Character	Annuals	Stationary perennials	Wandering perennials	Woody perennials
Vegetative life span	< 1 year	2 to a few years	Long, indefinite	Long
Vegetative propagation	No	Accidental	Yes	Some species
Usual seed persistence	Years to decades	Years to decades	A few years	Months to years
Energy allocated to seed production	High	Medium high	Medium low	Low
Seed size[a]	Mostly small	Mostly small	Mostly small	Mostly large
Usual mode of establishment	Seeds	Seeds	Vegetative propagules	Seeds
Main dispersal modes	With soil, manure	With soil, wind, feces, crop seed	With soil	Birds, wind
Position in succession	Year 1 (2 in gaps)	Year 1 to 5 (10)	After year 1	Middle
Taxonomy	Monocot and dicot	Mostly dicot	Monocot & dicot	Mostly dicot
Crop types	Annual	Forage, annual	All	Orchard, pasture, swidden, no-till
Examples	*Chenopodium album* *Setaria faberi*	*Rumex crispus* *Poa annua*[b]	*Imperata cylindrica* *Convolvulus arvensis*	*Lantana camara* *Toxicodendron radicans*

Notes:

[a] Seed size ranges and medians from an analysis of 39 annual, 18 stationary perennial, and 16 wandering perennial British weed species of arable land and well-drained grassland reported in Salisbury (1961) were 0.02–35 (1.1), 0.2–3 (1.2) and 0.13–14 (0.7) mg, respectively, indicating no difference in seed size between the three categories.

[b] Because *Poa annua* sets seed during its first season of life, it can behave as an annual in annual cropping systems. However, if left undisturbed it usually lives at least two seasons, and often sets more seed the second year (Law, Bradshaw & Putwain, 1977).

Booth et al. (2010)

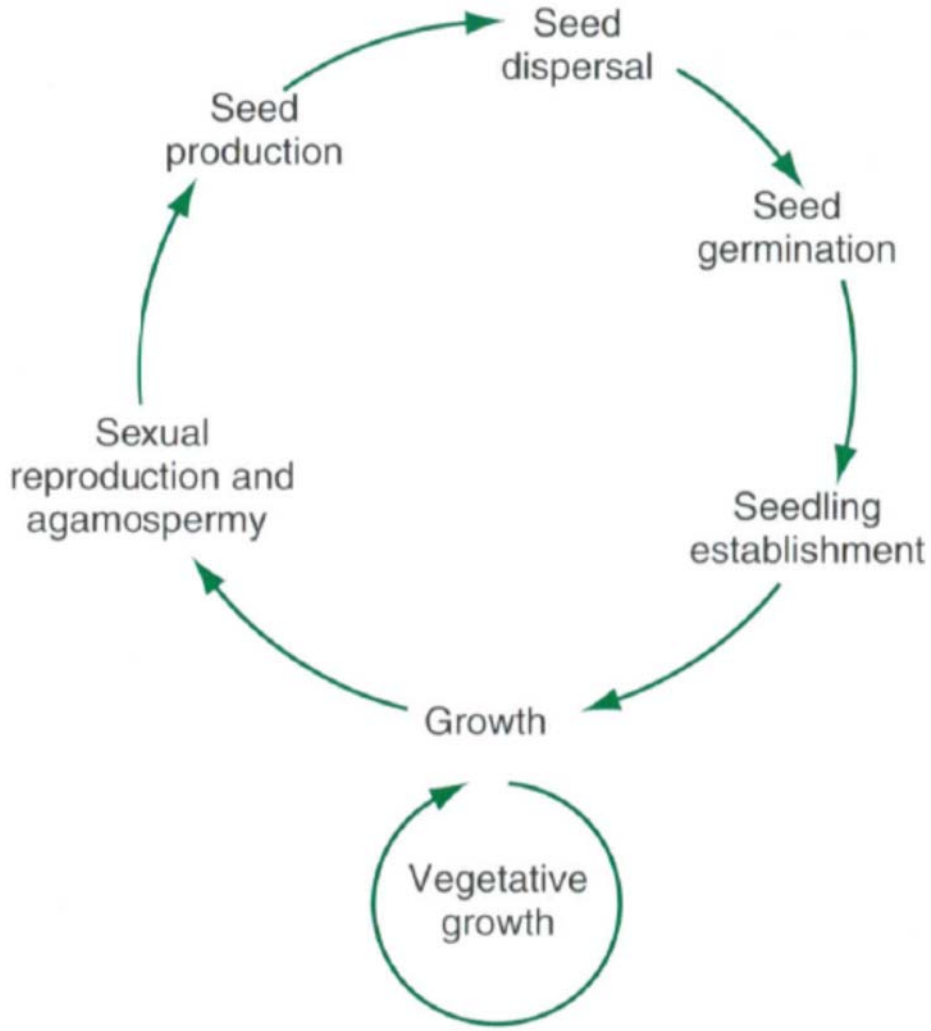
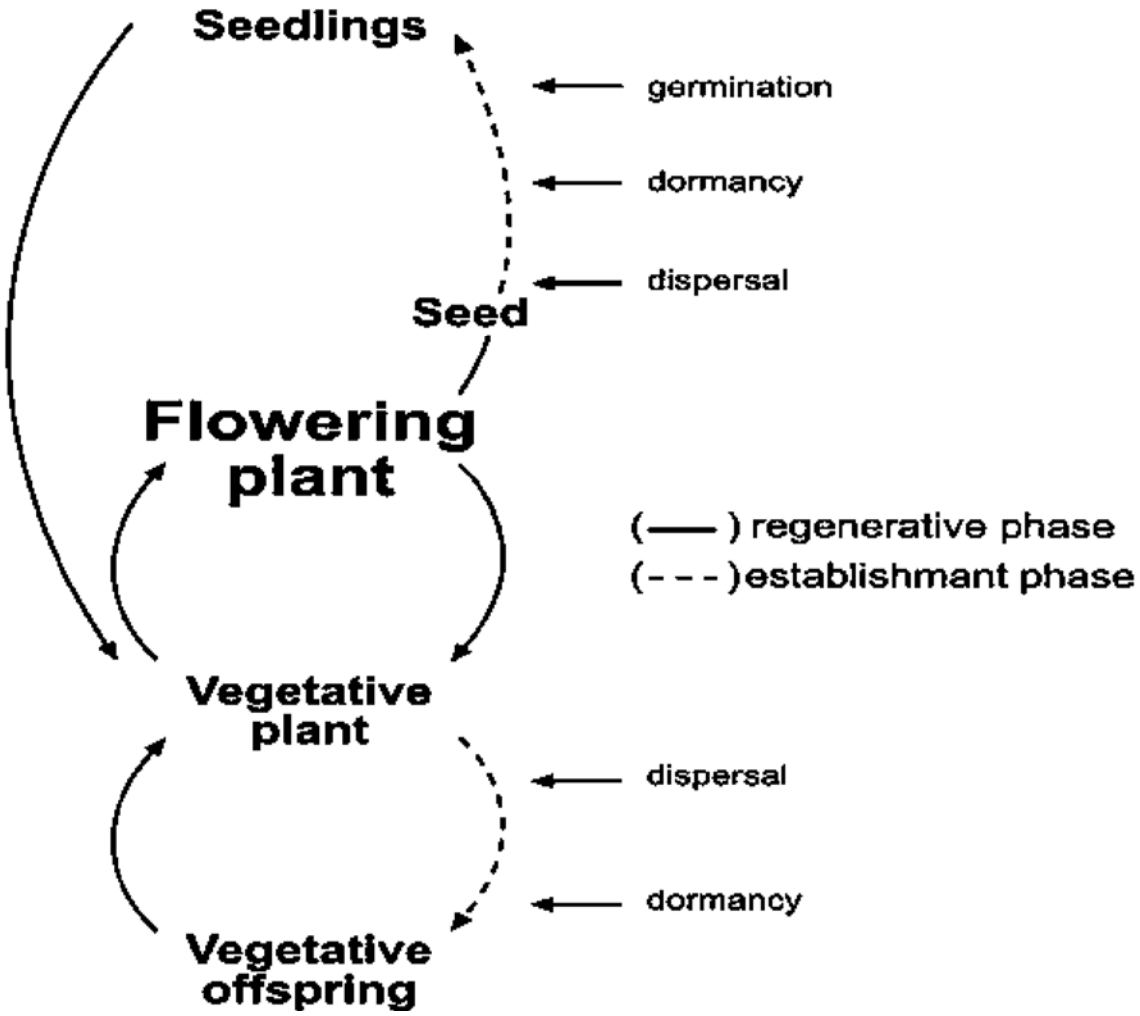


Fig. 6.1. The life cycle of plants has no real beginning or end. One chooses an arbitrary 'start'.

Figure 2. Life cycle of perennial plants producing both seeds and vegetative organs (from Williams, 1997).



Booth et al. (2010)

Table 5.1. Definitions of asexual reproduction structures and examples of weeds using them.

Term	Definition	Examples
Creeping stems		
Rhizome	A horizontal, underground structure connecting ramets. It may bear roots and leaves and it may be cordlike or fleshy.	Bermuda grass (*Cynodon dactylon*) Quack grass (*Elymus repens*) Kentucky bluegrass (*Poa pratensis*) Field horsetail (*Equisetum arvense*)
Stolon and runner	An above-ground, horizontal branch (stolon) or stem (runner) connecting ramets or plantlets. Roots and shoots develop from nodes.	Bermuda grass (*C. dactylon*) Creeping bent grass (*Agrostis stolonifera*) Strawberries (*Fragaria* spp.) Crabgrass (*Dactylis glomerata*)
Tuber	An underground storage organ formed from the stem or root and lasting only 1 year. New tubers are formed each year from different tissue.	Yellow nutsedge (*Cyperus esculentus*) Purple nutsedge (*Cyperus rotundus*) Field horsetail (*E. arvense*)
Shoot bases		
Bulb	A fleshy underground storage organ composed of leaf bases and swollen scale leaves.	Wild onion (*Allium vineale*) Lilies (*Lilium* spp.) Wild garlic (*Allium sativum*)
Bulbil	A small bulb developing from an above-ground shoot either in place of a flower (vivipory) or on a lateral shoot.	Wild onion (*A. vineale*) Wild garlic (*A. sativum*)
Corm	A non-fleshy underground storage organ formed from the swollen base of the stem.	Buttercup (*Ranunculus bulbosus*) Oat grass (*Arrhenatherum etatius*)
Root suckers		
	Above-ground shoots that emerge from creeping roots, tap roots or root tubers.	Canada thistle (*Cirsium arvense*) Field bindweed (*Convolvulus arvensis*)