Reproduction in Weeds

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- By the end of this lesson, you should be able to –
  - define the four major breeding systems in weeds and describe the genetic variability associated with each
  - understand the relationship between population genetic diversity and weed management
  - describe two advantages and two disadvantages to the major forms of plant reproduction
  - list up to five ways that weed seed are dispersed
  - understand the relationship between life form and weed management.

Weed Reproduction

- Weeds most often reproduce by seed.
- Some weeds reproduce through vegetative means.
  - new individuals formed from multicellular structures of a single plant.
  - vegetative reproduction is a trait that is shared by 60% of the world's worst weeds.
  - reproduction by vegetative methods makes weed control extremely difficult.

Weed Reproduction

- An understanding of a weed's **breeding system**, **methods of propagule dispersal**, and **life form** is important.
- These attributes can be used to predict population spread and longevity.
- They can also be used to predict genetic diversity within and among populations.
- The more genetically diverse a population:
  - the more it is buffered from management strategies
  - more likely that individuals are present that can adapt to the strategy.

Breeding Systems in Plants

- Outcrossing
- Self pollination
- Clonal
- Mixed mating

- Breeding systems for many weeds are not well known.

Outcrossing in Weeds

- The gametes that form the zygote are genetically dissimilar.
  - Self-incompatibility may be involved.
  - Outcrossing may occur between closely related individuals.
    - Inbreeding depression
- Leads to more diversity within a population.
- Leads to less diversity among populations.
  - Populations from different geographies are not very specialized.
- At low densities there may not be enough pollen to produce the full potential of seed.
- If the species is an obligate outcrosser, at least two plants are required to start a new population.

Self-pollination in Weeds

- The gametes that form the zygote are genetically very similar.
- Leads to less diversity within a population.
  - A population can be relatively homozygous.
- Leads to more diversity among populations
  - Populations from different geographies can be very specialized.
- If the species can self pollinate, only one plant is required to start a new population.

Vegetative Propagation in Weeds

- Offspring are genetically identical to the maternal parent.
- Within population diversity can be hard to predict.
  - is it a mixture of clones?
  - is it only one clone?
  - mutations are preserved.
- Among population diversity also can be hard to predict.
- It only takes one plant to start a new population.

Mixed Mating Systems in Weeds

- May be the most common method in weeds.
- The distribution of heterozygotes, homozygotes, and clones depends on the proportion in the original population.
- Some common combinations
  - Facultative selfing in an outcrossing species
  - Predominately selfing with a low level of outcrossing
  - Outcrossing with clonal capacity
  - Facultative apomixis

Apomixis

- An asexual form of reproduction where a seed is formed without fertilization.
  - Somatic cells or gametes in the mother plant develop into an embryo.
  - Examples - Hawkweed (*Hieracium* spp.), dandelion (*Taraxacum*), some citrus (*Citrus*), blackberries (*Rubus* spp.), and Kentucky bluegrass (*Poa pratensis*)

Advantages to Seed Production

- Much more genetic diversity.
- Seed are a complete package.
  - Preserved in time.
  - Preserved against harsh environments.
  - Seed are easily dispersed.
  - Many seed are produced.
    - Depends on the presence of competitors.

Examples of Seed Production

Weed species	Seed per plant	Competitors
Without competitors		
Powell amaranth	100,000	No crop
Scentless chamomile	Up to 300,000	None
Common purslane	Up to 2,000,000	None
Common chickweed	30,000	No crop
Wild mustard	30,000	No crop
With competitors		
Velvetleaf	60-70	Corn
Powell amaranth	30,000	Brocolli
Giant ragweed	230	Corn
Barnyardgrass	100,000	Tomato
Green foxtail	28,700	Soybean
Wild mustard	328	Wheat

Source: R.F. Norris. 2007. Crop Prot. 26:182-188.

Disadvantages to Seed Production

- Species that produce many reproductive units (seed) may be less competitive than those that produce primarily vegetative growth.
- WHY???

- Producing seed uses resources that could be used for plant competition.

Vegetative Reproduction

- Many types of vegetative propagules are known.
- Vegetative reproduction occurs through modification of a stem that grows horizontally.
  - underground stems or rhizomes
  - roots
  - aboveground stems or stolons
  - corms, bulbs, and tubers (storage for carbohydrates)

Advantages to Vegetative Reproduction

- Can create clones of a successful genotype and provide genetic stability.
- Can establish a new population from one plant or propagule.
- Storage organs propagate rapidly and in large quantities.
- Usually difficult to control.

Disadvantages to Vegetative Reproduction

- Limited genetic variability and mutations are preserved.
  - Less adaptable
  - Expected to be well controlled by biological agents
- Relatively limited dispersal.
- Shorter lifespan of propagules compared to seed.
  - Sensitive to temperature and moisture extremes.

Propagule Dispersal

- Pollen, seed, and fragments of reproductive vegetation are the mechanisms by which weeds spread.
- Pollen
  - Paternal alleles only
  - Produced in vast numbers
  - Usually wind or animals as vectors
  - Has a very short life span
  - Occurs between the same and related species

Seed Dispersal

- Seed contain both sets of nuclear alleles.
  - Plus maternal mitochondrial and chloroplast alleles.
- The majority of seed is dispersed by gravity.
  - Seed remain near the maternal parent.
- May also move with animals, wind and water.
- Mechanical – ballistic expulsion of seed.
  - Example????
- Vectors – in the context of weed science and management, we are concerned mostly with movement by vectors.

Seed Dispersal

- Dispersal occurs
  - between continents or islands
    - in a ship ballast, with crop seed, intentional movement as a new crop or ornamental, accidental movement, maybe birds
  - within continents = between regions
  - within regions = between habitats
    - railroads, trucks, sharing equipment

Management of Seed Bearing Weeds

- The juvenile period in weeds is often very short
  - May produce seed quickly.
  - Must be aware of seedlings and control them before they set seed.
- Weed seed may be viable even if immature.
  - You should remove the entire plant from the field if pulled.
  - You should apply weed control before seed are viable.
  - Sometimes a late application of a herbicide can reduce viablity.

Weeds that Reproduce Vegetatively

- Good candidate for herbicides.
  - **Phloem mobile** herbicides translocate into underground structures and kill the entire plant.
- Good candidate for biological control.
  - The equilibrium that exists between populations of insects and weeds usually maintains the weeds at an acceptable threshold.
- Not good candidates for mowing, hand-pulling, and grazing of these weeds due to their extensive underground structures and carbohydrate reserves.
  - Can even increase due to the subsequent changes in apical dominance.

Life Form- Annual

- Annual plants reproduce very quickly – some in as little as six weeks.
- These plants have highly differentiated populations.
- These species are traditionally weeds in annual crops. They can be difficult to control because their life cycle mimics that of the crop, and they well adapted to disturbance.

Common chickweed, green foxtail, and redroot pigweed are annual weeds. Photos courtesy of The Weed Science Society of America.

Life Form - Biennial

- Biennial plants complete their life cycle in two growing seasons.
  - Germinate and form a rosette the first year.
  - Second growing season form a stem, flowers, seed and die.
  - These plants are progressively less adapted to disturbance.
  - Examples

Bull thistle (*Cirsium vulgare*)

Bull thistle (*Cirsium vulgare*) is an example of a weed with a biennial life cycle. Photos courtesy Virginia Tech Weed ID Guide.

Life Form - Perennial

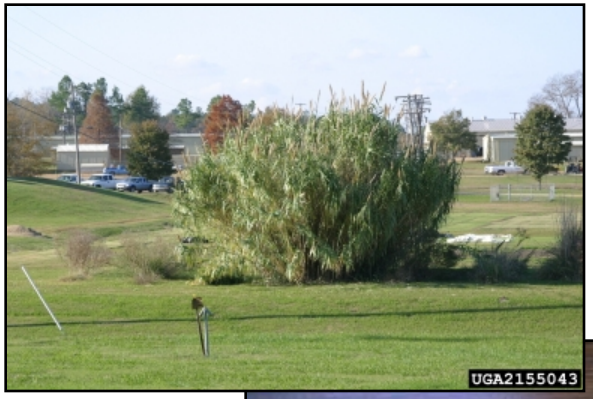
- Short-lived perennial (lives 3-5 years)
- Long-lived perennial (lives for more than 5 years)
- Perennials in general have less among-population diversity compared to other life forms due to infrequent sexual recombination, and do not tolerate disturbance well.

Canada thistle (*Cirsium arvense*) is an example of a weed with a perennial life cycle. Photos courtesy Virginia Tech Weed ID Guide.

Canada Thistle (*Cirsium arvense*)

Photos courtesy Virginia Tech Weed ID Guide.

Giant Reed (*Arundo donax*)



Photos courtesy The Galveston Bay Estuary Program.

Weeds With Mixed Mating Systems

- Field bindweed (*Convolvulus arvensis*) – rhizomes & seed
- Quackgrass (*Agropyron repens*) – rhizomes & seed
- Oxalis (*Oxalis* spp.) – bulbs & seed
- Wild garlic or wild onion (*Allium* spp.) – bulbs & seed
- Nutsedge spp. (*Cyperus* spp.)
  - Purple nutsedge (*C. rotundus* L.) – tubers produced at the end of rhizomes and a few seed
  - Yellow nutsedge (*C. esculentus* L.) – tubers and seed

Reproduction in Weeds

- This lesson provided information on –
  - the four major breeding systems in weeds and the genetic variability associated with each
  - the relationship between population genetic diversity and weed management
  - several advantages and disadvantages to the major forms of plant reproduction
  - several ways that weed seed are dispersed,
  - the relationship between life form and weed management.