PLANT RESPONSE TO DISTURBANCE

This discussion is based on:

Briske, D. D. 1991. Developmental morphology and physiology of grasses. p. 85-108. In: Grazing Management: An Ecological Perspective. R. K. Heitschmidt and J.W. Stuth (eds.) Timber Press, Portland Oregon.

Main Points:

Various kinds of disturbance (e.g., grazing by invertebrates and vertebrates, trampling, fire, cutting) affect the ability of plants to survive, grow, and reproduce.

Plants have evolved mechanisms for avoiding and tolerating disturbance. The availability of resources in the environment (e.g., sunlight, soil fertility, soil moisture) affect the phenotypic expression of such mechanisms.

Understanding how plants avoid and (or) tolerate disturbance provides a basis for management. **Grazing Resistance** is the ability of plants to survive grazing.

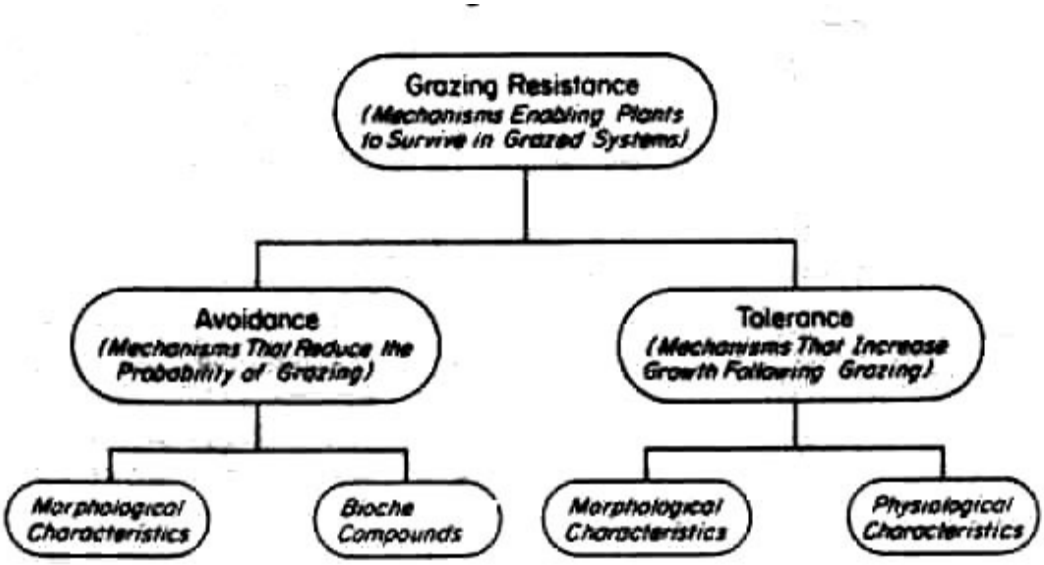


Figure 4.7. Organization of grazing resistance into avoidance and tolerance components. Avoidance mechanisms decrease the probability of grazing while tolerance mechanisms increase growth following grazing (adapted from Briske 1986).

- **Grazing Avoidance Mechanisms** - *Plant attributes that reduce the probability or severity of grazing (i.e., escape mechanisms that effect accessibility and palatability)*

  - **Mechanical**

    - **Thorns, Prickles, Spines** - *The characteristics make the plant less likely to be grazed by large herbivores; not effective against insect herbivores.*

      In some cases, these defenses are **inducible**; *grazing can accelerate or intensify the production of these characteristics by the plant.*

    - **Growth Form** - *Specific growth forms can reduce the amount of biomass lost in grazing events. The effectiveness of any particular growth form depend on the grazing skills of the herbivore.*

- Bunchgrasses often loose more biomass when grazed than sodgrasses.
- Plants with prostrate growth forms tend to avoid grazing.

- **Plant size** - *Grazing intensity is inversely related to basal area of grasses. This relationship between grazing intensity and plant size is likely true for forbs and shurbs.*

- **Location of Meristems** - *Plant that protect their meristems or keep them out of reach of herbivores (i.e., low to the groung) experience lower grazing intensities (i.e., avoid grazing). This generally explains why forbs express less mechanical grazing avoidance than grasses.*

- **Live:Dead ratio of culms or shoots** - *A higher proportion of dead stems decrease the probability that the plant will be grazed.*

- **Biochemical** - Secondary compounds in plants (i.e. alkaloids, tannins, essential oils)

- How do they work?
  - *Reduce palatability. That is, they "taste bad." Usually, this bad taste is a result of a conditioned taste aversion*
  - *Sometimes they kill the herbivore which can reduce the probability of future grazing... at least by that particular herbivore.*

- Protect grasses, forbs, and shrubs from grazing - *but, mostly important in forbs and shrubs which generally have greater quantities of secondary compounds.*

- May **not** have evolved to deter grazing - *They certainly are effective to deter herbivores, however they probably evolved to protect the plant from insect, pathogens (i.e., bacteria and fungi), or other plants.*

- Influenced by environment and animal characteristics.
  - *There is great variation in plant toxicity from plant to plant or even within the same population of plants.*
  - *Weather and soil characteristics can also affect how toxic or unpalatable a plant is.*
  - *Not all animals are effected the plant compounds in the same way.*

- Grazing induced defenses - *the chemical defenses of plants can also be induced by grazing events.*

- **Grazing Tolerance Mechanisms -** *Plant attributes that facilitate growth following defoliation.*

  - **Morphological Mechanisms**

    - Leaf replacement potential - *The rate at which leaf area is reestablished following defoliation. This is largely a function of the number, source, and location of meristems within a plant.*

    - Meristematic potential for growth -
      - *Growth is most rapid from intercalary meristems because cells are already differentiated; they just need to grow.*

      - *Growth from axillary buds requires differentiation and growth of cells.*

      - *Axillary buds are particularly important because they are what survive from year to year.*

- Apical dominance - *The apical meristem suppresses growth from axillary buds. When buds are removed the axillary buds often initiate growth which causes "tillering" in grasses.*

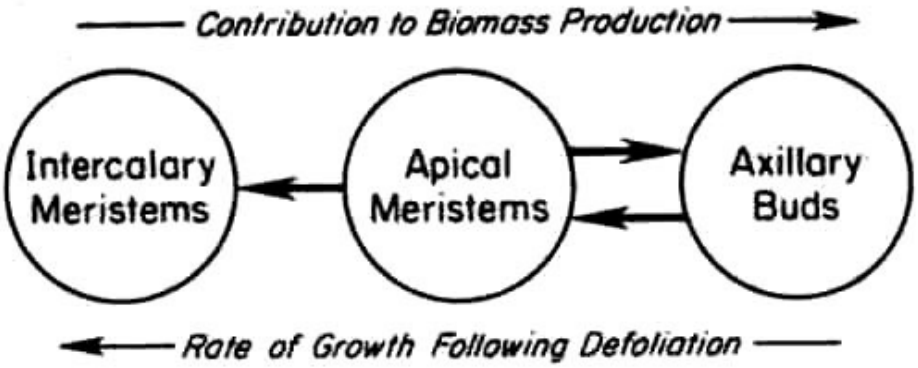


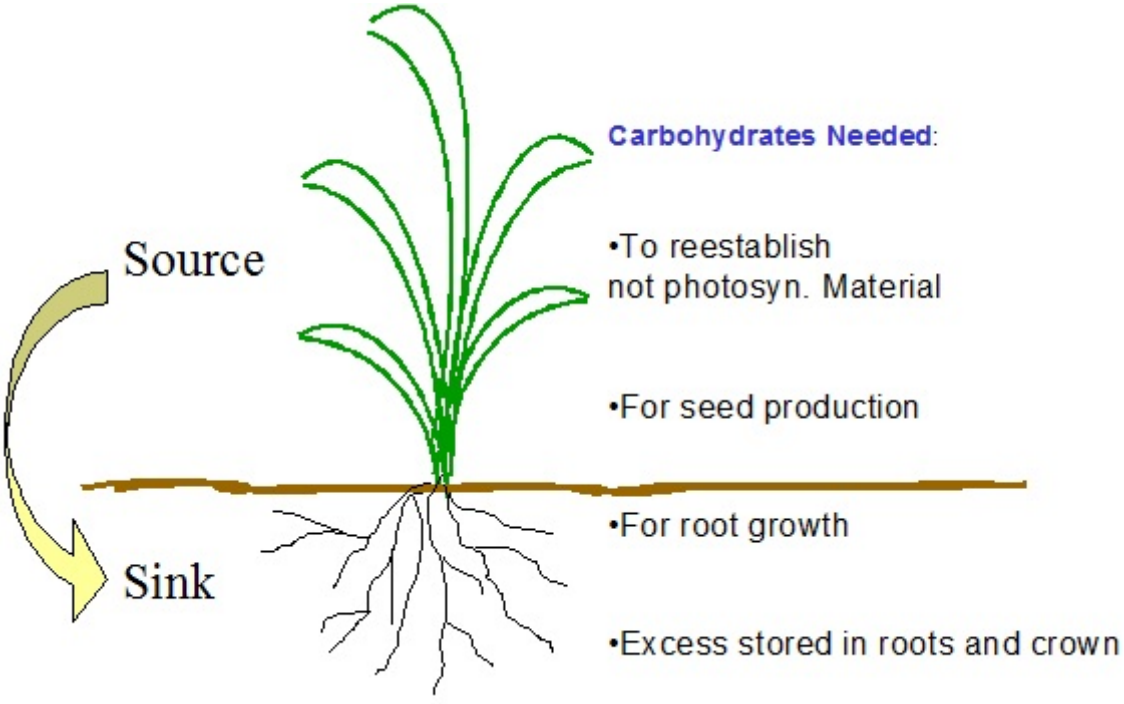
Figure 4.9. Sources of meristematic activity in a grass plant. The relative growth rate from each source following defoliation is established by the extent to which tissue differentiation has previously occurred. Axillary buds confer perenniality to the plant while intercalary meristems are relatively short-lived (from Briske 1986).

○ Physiological Mechanisms

- Compensatory photosynthesis - *the increased rate of photosynthesis that occurs in some plants following grazing. It does occur but its significance to grazing tolerance appears to be limited.*

- Carbon allocation patterns - *Ability to rapidly relocate CHO's may increase ability to recover from disturbance (i.e., be flexible).*

  - *Need to think about the "source and sink" for the products of photosynthesis. What creates the CHO's needed for regrowth after grazing.*



Summary

- What characteristics make a plant **grazing resistant**?
  - **Plant Morphology and Growth** (*these are really general rules for which there are plenty of exceptions)*
    - Should plants elevate apical and axillary meristems?
      - *as little as needed*
      - *delay elevation as long as possible*
    - Should the ratio of reproductive to vegetative tillers be high or low?
      - *Grasses with low relative numbers of reproductive tillers tend to have great grazing tolerance.*
      - *Grasses with high relative numbers of reproductive tillers tend to have great grazing avoidance (i.e., crested wheatgrass)*
    - How many axillary buds (from which tillers grow) should a plant have?
      - *A lot! Some plants do not have enough axillary buds to recover from grazing*
    - How quickly should a plant produce new tillers after grazing?
      - *The quicker the better. The sooner tillers are produced the more quickly the plant can start photosynthesizing again.*
    - Possess spines or thorns that reduce the chances of herbivory
  - **Plant Physiology**
    - Increased photosynthetic rates
    - Increased nutrient absorption
    - Inherent ability to compete for moisture/nutrients
    - Possess chemicals that reduce palatability
- **Guidelines for Grazing Systems:**
  - The **dormant period** is the least critical time for foliage removal. At this time, the plant is not actively photosynthesizing and plant does not try to regrow after being grazed. However, grazing during this time may be detrimental to shrubs which are maintaining and forming buds which are accessible to herbivores.
  - The **period of growth initiation** is intermediate with respect to potential damage from defoliation. The plant is actively growing and has significant demand for photosynthetic products. However, the conditions for growth are optimal (i.e., plenty of soil moisture and nutrients). This active photosynthesis can provide the CHO's necessary for growth. During drought years this period of effective soil moisture may be limited and grazing may be detrimental until the plant becomes senescent.
  - The most critical time for foliage removal for most plants is the period from **floral initiation through seed development**. During this time, the plant's demand for soluble CHO's is considerable as the plant is near peak biomass (i.e., has a lot of biomass to support) and is using CHO's for seed development. Defoliation can also be detrimental

during this time because the conditions for active photosynthesis are less favorable (i.e., less soil moisture, higher temperatures)

- **The Bottom Line**

  - It isn't easy to determine how grazing will influence a plant community. Plants have abilities to grow in a world that included defoliation. However, some plants are better at avoiding grazing or responding to defoliation than others. Furthermore, these abilities and responses depend on the season in which defoliation occurs and the other plants in the neighborhood.

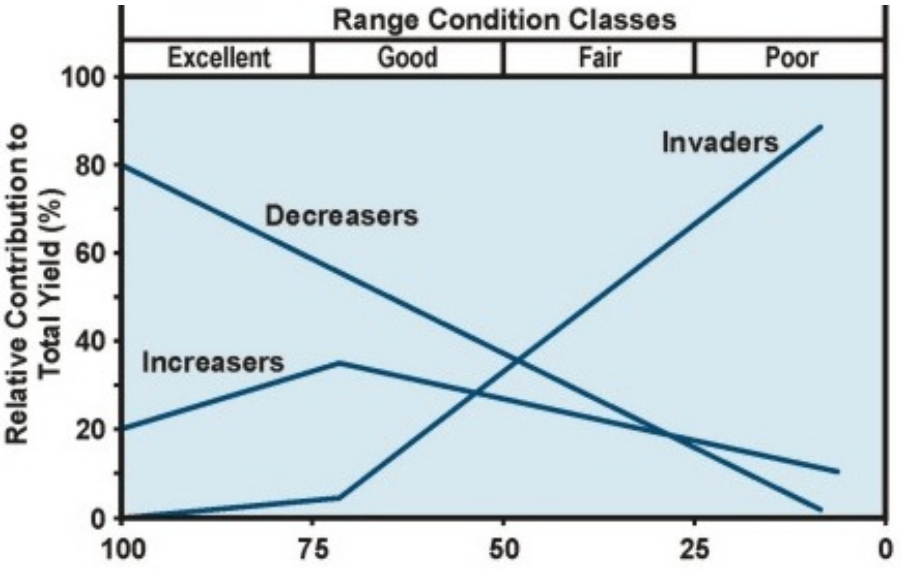
  - Our skill as rangeland managers depends on our ability to assess these plant abilities and responses. Because plants evolved with herbivory the question is probably not "To graze or not to graze?" The real useful question is "When and how much to graze?"

- **Plant Response to Grazing** - Range managers "***traditionally***" classify plants based on level of grazing resistance or response to grazing:

  - Decreaser plants are the first plant to die out under continued heavy grazing. These native plants decrease because they are either quite palatable and sought out by grazing animals or they lack physiological attributes that help them recover from grazing.

  - Increaser plants are native plants that generally increase their numbers as decreaser plants are reduced. Many increaser plants avoid grazing damage because they grow close to the ground or are less palatable than decreasers. Increasers often also possess physiological mechanisms that help them recover from grazing. These plants should be watched with caution because they are a sign of high grazing pressure and can increase in number and abundance beyond what is desirable. If overuse continues, even increaser plant may not survive.

  - Invader plants are commonly weedy plants that become established because more desirable plants have been diminished by excessive grazing. Invaders are usually signs of overgrazing. However, many noxious rangeland weeds are able to invade into even healthy range communities, such as leafy spurge and yellow star thistle.



(This is an "out of date" and "traditional view...but you will still see the terms use. More info at: www.pnr-rpn.ec.gc.ca/nature/whp/prgrass/df03s04.en.html)