Resprouting Biology

Following is a basic explanation of the biology, a listing of some resprouting advantages, and some important definitions of various resprouting methods. Click here for a link discussing how to apply it to management practices.

The 3 fundamental biological elements of woody growth are apical dominance, C_3 photosynthetic pathway, and resprouting morphology.

Apical dominance is when the topmost growing point controls the growth of lateral roots; and it maintains this control until it is disturbed (Cline 1997; Dun et al. 2006). Once the top growth is removed or damaged (e.g. fire, grazing, mowing) apically dominate woody plants respond by resprouting at the base; reaction times are species specific (Cline 1997; Sigma-Aldrich 2016).

Bushes and trees use the C_3 photosynthetic pathway. This makes them more competitive than C_4 plants at processing carbon dioxide (CO_2) and water into food under cool, moist conditions. These plants are growing and getting a head start in the early months of spring. Most plants using C_3 photosynthesis are also shade tolerant and most of the unwanted woodies exhibit apical dominance.

Some resprouting woodies are also clone forming. Common pricklyash (*Zanthoxylum americanum*) is one example. When the apical meristem is damaged, not only does it resprout from the base adding additional flowering stems, it sends underground runners to establish another colony nearby.

Cytokinin, auxin, and gibberellins are phytohormones that promote root and shoot growth. Made in the roots and also in the seeds and fruits, cytokinins travel up the xylem and promote lateral growth. Since auxins travel down from the

growing tip and act to suppress lateral growth, these two types of hormones strike a balance. This push-me-pull-me aspect of woody resprouting growth is maintained by certain plant hormones and is an important concept.

Auxins

Auxins are the main plant growth hormones responsible for cell elongation (Boundless 2016). The term is derived from Greek meaning “to grow.” They control the differentiation of meristem into vascular tissue (phloem and xylem) and promote leaf development. Apical dominance (the inhibition of lateral bud formation) is triggered by auxins produced in the apical meristem (Boundless 2016).

When the apical bud is removed, the source of auxin is removed. Without the inhibitory effects of the high auxin concentrations, lateral buds begin to grow. In fact their growth is stimulated by a relatively small drop in auxin concentration. Thus, decapitating a shoot without killing it will cause it to resprout.

Cytokinins

Cytokinins are any class of plant hormones involved in cell growth and division (Boundless 2016).

They are most abundant in growing tissues, such as roots, embryos, and fruits, where cell division occurs. They are known to delay senescence in leaf tissues, promote mitosis, and stimulate differentiation of the meristem in shoots and roots. Many effects on plant development are made under the influence of cytokinins, often in conjunction with auxin. For example, apical dominance seems to result from a balance between auxins that inhibit lateral buds and cytokinins that promote bushier growth (Boundless 2016).

Gibberellins

Gibberellins are a group of about 125 closely-related plant

hormones that stimulate shoot elongation, seed germination, and fruit and flower maturation. Gibberellins are synthesized in the root and stem apical meristems, young leaves, and seed embryos. They are responsible for breaking dormancy (a state of inhibited growth and development) in the seeds of plants that require exposure to cold or light to germinate.

The stages of apical dominance or the "push-me-pull-me" process of resprouting behavior.

This diagram represents how apical dominance works. This is what I call the push-me-pull-me process of resprouting.

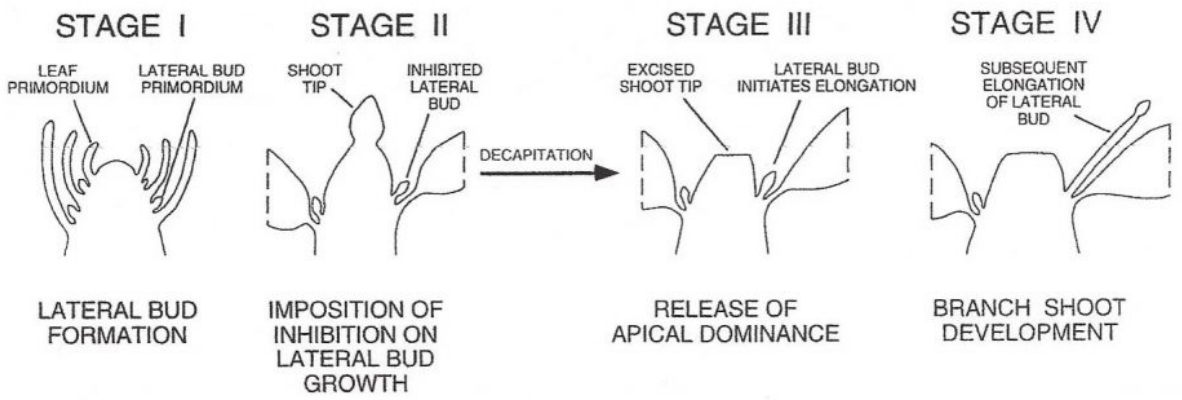


Fig. 1. Developmental stages of apical dominance before and after release by decapitation of the shoot apex.

Source: Cline, Morris G. 1997. Concepts and terminology of apical dominance. American Journal of Botany 84(9): 1064-1069.

Stage 1 – This is a new plant or seedling. Cytokinin is promoted for growth and is produced in the roots or top of the stem. Cytokinins increase cell division by stimulating the production of proteins needed for mitosis.

Stage 2 – Apical dominance is demonstrated. As long as the shoot tip remains, auxin is released. This keeps the growth at the tip and suppresses the lateral buds.

Stage 3 – Apical dominance is destroyed by removal of the shoot tip. Once the tip is removed, damaged, or destroyed, cytokinin is released and the lateral buds begin to grow.

Stage 4 – The lateral buds elongate, creating a separate shoot and establishing their own apical dominance. This happens as

auxins and gibberellins are promoted.

Reprouting advantages

From the woodies' perspective, their goal is to occupy sites with as much biomass as possible for as long as possible (Bellingham and Sparrow 2000). Resprouting is an evolved key competitive strategy for increasing the life of the seedling when plants experience loss of aboveground biomass (Del Tredici 2001; Vesk 2006). Nearly all flowering, seed-producing and fruit-setting woodies (angiosperms) can resprout when young (less than 6" diameter) and many can after reaching adulthood (more than 6" diameter) (Del Tredici 2001). The post-fire nutrient increase created by microbe activity that enhances plant growth also enhances established woody growth (Briggs et al. 2005).

Characteristics of resprouters, which give them the advantage over non-resprouters:

- Resprouters are more widely distributed (Bond and Midgley 2001);
- Resprouters allocate more resources to roots and have "higher levels of non-structural carbohydrate in the roots" than species killed with fire (Clarke and Knox 2009; Clarke et al. 2012);
- They grow rapidly and tall to escape fire (aerial) and store nonstructural carbon (basal) before they are shaded (Clarke et al. 2012);
- They have lower reproduction costs because their larger offspring are more able to survive environmental stress (Hoffman 1998);
- Their bud locations are generally at or below soil level but varies with species (Clarke et al. 2012); this is a key criteria that defines resprouting ability;
- They allocate 4-5 times more sugar and starches to their roots than non-sprouters (Bond and Midgley 2001; Clarke and Knox 2009; Clarke et al. 2012). This ability to

store the necessary nutrients, sugars, and starches for future use is another reason resprouters are hardy and quick to recover from disturbance.

Sprouting Morphology

There is a medley of resprouting morphology or forms. Knowing the mechanism and structure for resprouting isn't imperative to understanding that the plants resprout, but knowing there are different forms is beneficial. The possibilities include lignotubers, rhizomes, stolons, adventitious roots, root suckers, epicormic buds, and collar buds; these are categorized into three basic resprouting responses – "aerial, basal, and below-ground" (Clarke et al. 2012).

Clonal growth – vegetative production of ramets which achieve independence (Jenik 1994).

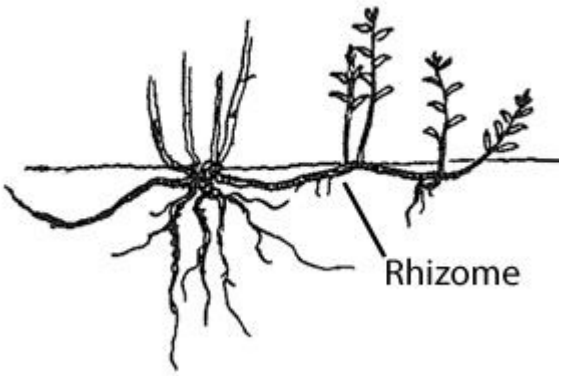
Ramet – A physiologically distinct organism that is part of a group of genetically identical individuals derived from one progenitor, as a tree in a group of trees that have all sprouted from a single parent plant. (source?)

Genet – A clonal colony or genet is a group of genetically identical individuals, such as a clone of prickly ash, that have grown in a given location, all originating vegetatively, not sexually, from a single ancestor. (source?)

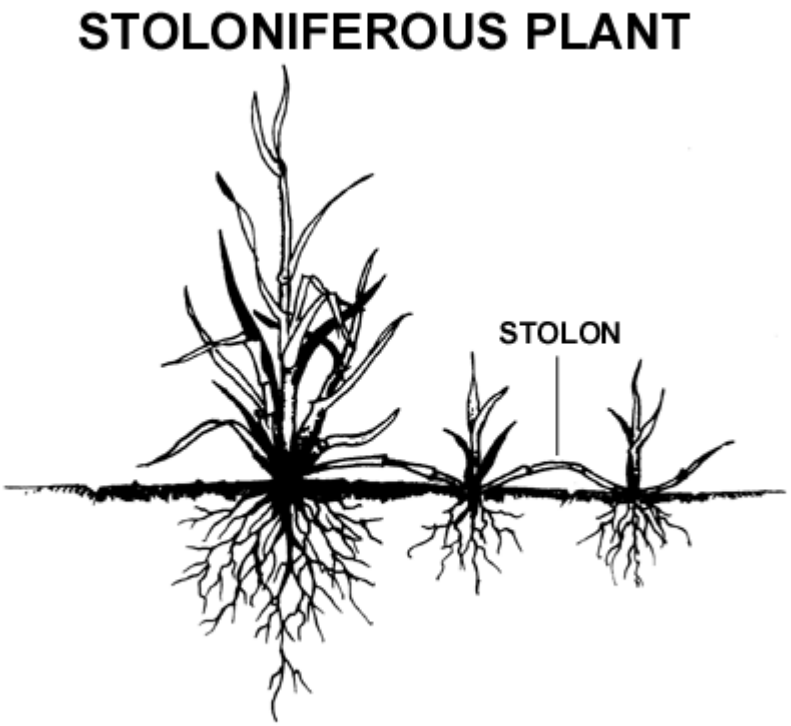
Lignotuber – develops from suppressed buds at the cotyledonary node of seedlings (think of autumn olive or boxelder)(Del Tredici 2001). These are dormant buds containing nutrients for bud development.

Lignotuber of a prickly ash

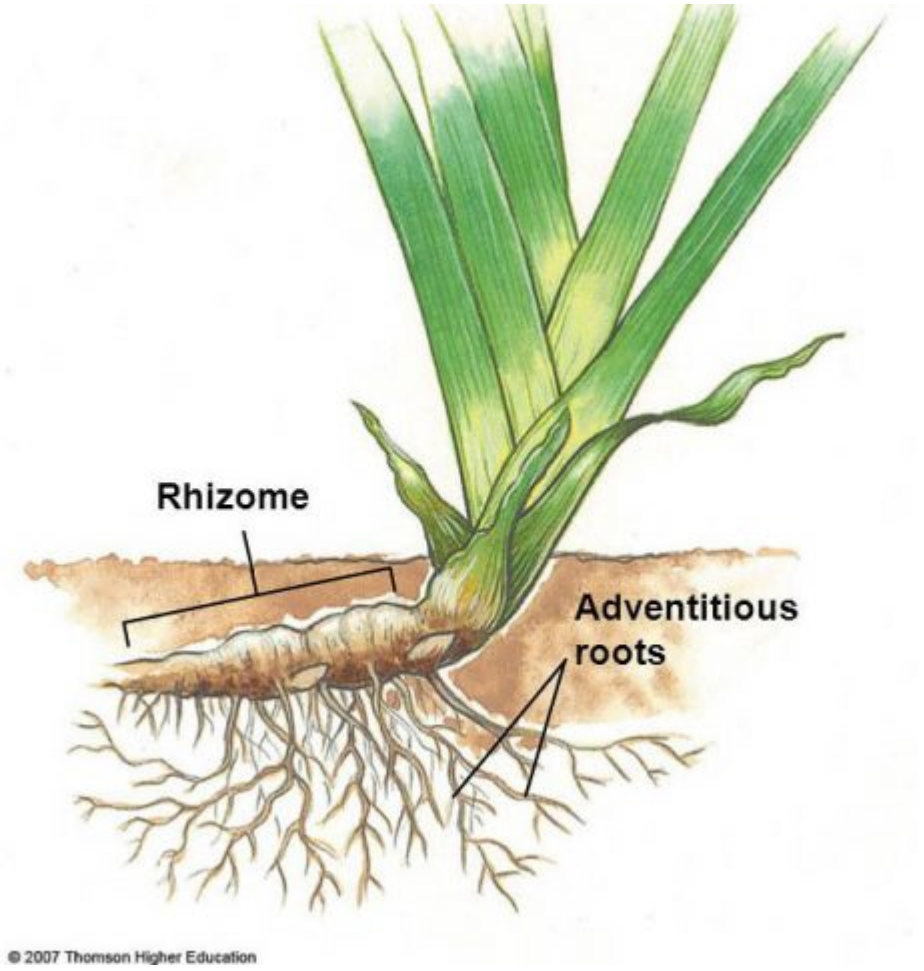
Rhizome – nodes that grow out from the base of the trunk and produce aerial stems some distance from the parent (think of sumac or prickly ash)(Del Tredici 2001).



Stolon – AKA runners – an aboveground creeping horizontal plant stem or runner that takes root at points along its length to form new plants. Horizontal connections between plants.



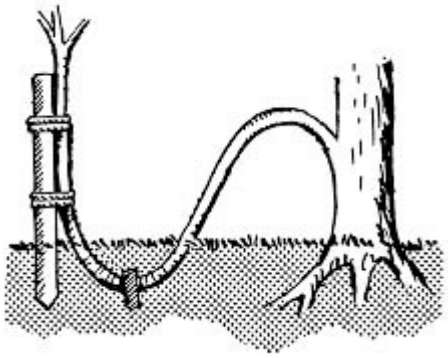
Adventitious roots – (aka sucker) Adventitious buds develop from places other than a shoot apical meristem, which occurs at the tip of a stem, or on a shoot node, at the leaf axil, the bud being left there during the primary growth. They may develop on roots or leaves, or on shoots as a new growth. Shoot apical meristems produce one or more axillary or lateral buds at each node. When stems produce considerable secondary growth, the axillary buds may be destroyed. Adventitious buds may then develop on stems with secondary growth. Adventitious buds are often formed after the stem is wounded or pruned.



Root suckers – shoots off the roots – usually only develop with trauma (sumac and prickly ash produce new stems spontaneously). Aspen and *Prunus* sp (chokecherry) another example. Frequent fire and logging favor the spread of root-suckering species (Del Tredici 2001).

Epicormic buds – these are suppressed buds high up on the trunk, limbs, or twigs. They have the same effect as collar buds (Del Tredici 2001, Jenik 1994).

Layered sprouting – these occur when a branch is forced to the ground while attached to the main tree. The portion touching the soil will develop adventitious roots; these can become individual trees. (Del Tredici 2001)



Layered sprouting

Coppice shoots – a young tree that has grown from a sucker and not from seed; a coppiced tree will have multiple stems growing from its base (think boxelder or honeysuckle).

Coppice shoots

Resources

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