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Plant Roots

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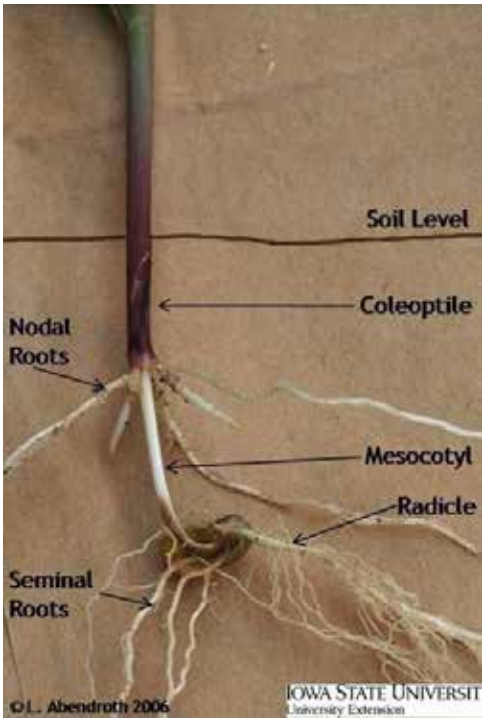

The first plant part to emerge from a germinating seed is a root, called the *radicle* (not radical) in both dicots ('broadleaf' plants) and monocots (grasses). The radicle helps the seed continue to pull in moisture from a larger volume of soil, as well as nutrients for growth. Ideally the radicle grows downward, not laterally along the furrow, and this is especially important for dicots (broadleaves). The radicle will not grow upward, since plants are responsive to both sunlight and gravity, which is communicated among plant parts via hormones. However, for a seed that is 'upside down,' the radicle will have to curve around the seed to begin its downward path.

This very early path of the radicle is far more crucial for dicots (broadleaf species) than monocots (grasses). Examples of broadleaf species include sunflowers, soybeans, cotton, canola & other brassicas, all peas & beans, alfalfa, clover, flax, deciduous trees, and so on. It isn't really about the size of the leaf, instead it's the shape of the leaves, and more definitively whether the first set of leaves coming from the seed are a pair (hence *di*cot, 'di' meaning two) or a single leaf (monocot). Corn (maize) has big leaves, but it is a monocot or grass. So is milo (sorghum), and of course all the species that more obviously look like grasses, such as wheat, oats, barley, millets, etc. However, the weed nutsedge isn't a grass, it is a sedge.

Rootless or 'tomahawk' roots result from overpacked sidewalls

For the dicots, you can get some idea from thinking about the seed: since the first two leaves are a matched set, usually the seed is susceptible of being split into halves along a line of weakness, and the halves mirror each other. These are the 'splits' in peas, beans, vetch, canola, etc. Flax also splits this way, but not so easily. Seeds of grasses may also break, but the halves are not usually mirror images of each other—most of what is the kernel of grasses is a big lump of starch with a small embryonic part embedded.

In dicots (broadleaves), the radicle becomes the taproot—and this is of great importance to those plants, and must grow downward, not sideways, for the plant to have maximum vigor as well as sturdiness against mechanical forces such as wind. The taproot needs to grow downward in a reasonably straight path since it is the origin of all the lateral roots growing out from it. Taproots may reach very deeply into the soil in some species, such as sunflower, alfalfa, and oak trees.

So, from a seed placement standpoint, it is especially important that seeds of broadleaf crops not be lying loose with a smeared layer under them.

Taproots of some dicot species may extend quite deep into the soil, but only if the radicle grows downward, not sideways -- which, in no-till, is strongly influenced by whether the seed is loose in the furrow, or thoroughly embedded in the bottom of the furrow.

The long root growing off to the right in the photo is the radicle, and is growing along the furrow because the seed didn't get pressed firmly into the bottom of the furrow. This isn't ideal, but it's usually not catastrophic for monocot (grass) crops, so long as conditions remain moist. Here, the seminal roots are visible, and appear to be growing downward through the furrow bottom, so all is well.

Roots follow the path of least resistance, and the radicle gets 'confused' if it emerges from the seed in low-density soil and then suddenly encounters high-density soil in its attempt to go downward. This is why dicot seeds in particular need to be embedded in the bottom of the furrow, usually best accomplished with narrow, in-furrow seed-lock wheels, or sliding firmers (Keetons are an example) with adequate pressure on them.

For grasses, the radicle is 'only' a bootstrap while more important roots get established. It isn't necessarily devastating if the radicle of grass crops grows along the length of the furrow instead of downward, although downward is still the best. In grass crops, after the radicle emerges from the seed, the next portion to emerge from the seed is the shoot which grows upward towards the soil surface. This is also called the coleoptile, which actually refers only to the outer protective sheath, which splits open at the soil surface to allow the first leaf inside to unroll and expand. The coleoptile also contains the growing point for generating a series of additional leaves that will emerge one at a time from the whorl. How long the radicle grows before the coleoptile makes its first appearance from the seedcoat is dictated by warmth and moisture. Meanwhile, the *seminal* roots are also emerging from the seed near the radicle; these are smaller than the radicle.

In grasses, as the second and third leaves are expanding rapidly from the whorl, the growing point for generating additional leaves has moved up inside the coleoptile to a certain spot and will begin growing rings of roots around it: The all-important nodal (from nodes), a.k.a crown roots. There are a series of these rings of roots, with the later ones often being called brace roots. For wheat, barley, and corn, if those seeds are placed at 1.5 - 2 inches deep, the first series of crown roots develops about 0.75 - 1" below the soil line. Milo, however, originates its crown roots near the soil line regardless of depth.

The crown roots go on to form the main root system of the grasses, and which branches in all directions from that crown (there's no central taproot). Once the crown roots are established, typically the radicle and seminal roots soon die off (if they die too soon, the plant will be stunted or die entirely).

With the all-important crown roots originating *above* the seed, they will grow and proliferate wherever conditions are favorable in having the correct water/air blend, so long as temperatures aren't too high. (Incidentally, the roots have no knowledge where more air or more water is to be found; they simply grow wherever it's conducive.) In tilled soils, the general tendency was for those crown roots to trend downward at about 45 degrees from vertical due to the soil surface being drier from tillage. In no-till with good mulch cover, however, the tendency is often for the crown roots to grow more laterally, and may even bend upward slightly to be right at the soil line under the thatch. These differences in growth patterns of crown roots make the ideal fertilizer placement with sideband openers different between the two tillage systems; see our DVD for more information.

Because of the importance of the crown roots to grass crops, and because the best yield potential is achieved with maximum root exploration of the largest volume of soil, we want the sidewalls of the furrow to be broken up, not smeared or 'slickened.' On disc-opener planters and drills with gauge wheels alongside the opener blades, this is usually done with covering discs

or spoked/tined closing wheels to break apart the smeared sidewalls. A different way of doing it is to not have a gauge wheel alongside the opener blade, although seed depth preciseness is compromised if the gauge wheel is farther away, and there will be lots of soil thrown out of the furrow by the blade(s), which can create another series of problems. Sidewalls can also be broken apart to a lesser extent if the gauge wheel is alongside the blade, but is either indented along the blade (RID), gapped away from the blade, or moved forward in relation to the blade such that the blade lifts the sidewall partially (sidewall blowout). Although these methods help reduce sidewall compaction, there is a cost again in terms of preciseness of seed placement, more soil disturbance causing weed seed germination, etc.

Although there are some notable exceptions, the planting industry on several continents has been moving towards the gauge wheel alongside the blade(s) for both planters and drills, single-disc or double-disc. This is true also where manufacturers of planters and drills take the no-till market a bit more seriously than in U.S. & Canada, such as in Argentina, Brazil, and Australia.

So, when double-disc openers are used, you really want *both* sidewalls crumbled, not just one. Those all-important crown roots should grow outward from both sides of the plant, not just one side. Even for dicots with their taproot, there are a great many lateral roots coming out from the taproot in the upper part of the soil, which is where the best nutrient supply is.

There are a couple of spike or tine closing wheel designs that tend to really dig in and may dislodge seed even at 2-inch depth. These manufacturers will often endorse or condone using just one spike wheel per row on the planter, and using the smooth rubber wheel on the opposite side. This is to prevent the spike or tine wheel from going too deep and roto-tilling out the seeds. But crumbling only one side of the furrow is a job only half done. Resolve to do better.

For more on how roots grow, see this article by Rick Waldren, UN-L, in *Leading Edge*, published by No-till on the Plains, Inc. in 2006.

For more on sidewall crumbling, see our May 2013 newsletter.