Is lodging getting you down? – causes and mitigation strategies

"Leaving a battery on concrete drains it faster than on wood" my father told me. Dutifully, I ensured my batteries were off the shop floor. I have since learned batteries discharge at the same rate no matter what they rest on, but despite the evidence, many people still cling to this misconception. Agriculture has its misunderstandings on how things work too.

Lodging has long been a problem for agriculture in reducing grain quality, harvestability, and yield losses. The most common perception is high nitrogen (N) causes lodging, because plants cannot support the heavy vegetative load. However, several other mechanisms contribute to lodging as well. Simply lowering N may not reduce lodging incidence, and may unnecessarily rob yield. The following discussion is a summary of a 2004 paper by Berry et. al. 2004, Understanding and reducing lodging in cereals. Advances in Agronomy. V 84 pgs 217-271.

Why do plants lodge? Lodging occurs when forces exerted on the plant exceed the plant's structural strength. From a biomechanical standpoint, leverage is the key concept in explaining lodging. Plant height, plant heads (ear) mass and surface area, the amount of water held in the ear and awns during a rain, and wind strength all contribute to exerting forces on the stem, roots, and soil. Two lodging types require defining to better understand the problem.

Stem failure occurs when plant stems kinks between the stem base and the seed head. This often occurs between the first and second internode, but can occur higher up the stem. Stem failure interferes with nutrient and water transport, as well as carbohydrate assimilation. Depending upon when stem failure occurs in the plant's lifecycle, yield losses can be significant.

Anchorage failure occurs when roots either break or bend, or if soil cohesion is reduced such that the roots slip through the soil. Anchorage failure may be evident if there is no stem kinking. Roots can shear off, or the root ball can compress the soil beneath it causing the plant to lodge. The ability of a root system to spread throughout the soil will help minimize lodging. Root spread can be influenced by several factors including: genetic traits, soil porosity and compaction, soil structure, plant density, root diseases and fertilizer placement and concentration.

Genetics. Semi dwarf genes have been bred into many varieties to reduce the leverage generated by taller plants. Also, future breeding selection for shorter, stronger straw and increased root mass may help reduce lodging incidence.

Tillage. Tilling prior to seeding loosens soil and reduces the structural anchoring support for plants, increasing lodging risk. It also reduces soil porosity and may induce a hardpan layer reducing root penetration. Direct seeding or minimum tillage maintains maximum soil strength and allows optimal root penetration through the soil to secure roots as much as possible. However, if tillage must occur, roll the soil either prior to seeding, or after emergence and prior to growth stage 20 (BBCH scale). Rolling has shown to increase the soils ability to provide a stronger substrate, with the exception of soils high in sand or organic matter.

Seeding rate. Careful examination is required when determining a causation for lodging. Do headlands lodge because of double the N or because there are double the seeds, or both? High seeding rates can decrease root mass due to competition for space creating a weak anchor. Its important to know this before making snap management decisions. Do not decrease seeding rates or N rates without justification. Fewer plants per square foot increases tillering, which creates uneven maturity, and makes management decisions difficult. For instance, when do you apply a FHB fungicide; when some heads are too advanced and others are not ready? A more uniform stand makes decisions simpler and fungicides more effective.

Seed Depth. Deeper seeding has not proven effective in increasing anchoring strength as most cereals tend to put out crown roots about 4 cm below the surface, regardless of seed depth.

Root Disease. Several root diseases can induce lodging at the roots or lower stem. Ensure when diagnosing that diseases are ruled out as a causal factor.

Plant growth regulators. These chemicals affect a plant's gibberellin biosynthesis or ethylene production. The objective

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is to reduce cell elongation and lower the rate of cell division. This may reduce plant height. Its effectiveness depends on timing, plant species, cultivar and environmental conditions at application. Lodging is often reduced and yield may increase, though not consistently. The exact mechanism to the reduction in lodging is not perfectly understood. It may be directly correlated to height reduction or changes in plant physiology. These physiological changes are inconsistent and not well understood. Unfortunately, MRL's for chlormequat chloride are not established with our largest trading partner, the U.S. If using a PGR, ensure no trade barriers exist for the type used before applying.

Nutrients. N is a factor in crop lodging. A high N supply increases early vegetation, which creates shading. This shading in combination with high N increases the lower internode length while also reducing stem diameter and stem wall width. High rates of N may also be linked with fewer roots which are thinner and weaker. All of which can contribute to lodging risk. An oversupply of most other nutrients does not seem to pose a risk for lodging.

Nutrient deficiency. When N is deficient, applying N increases stem wall thickness, root mass, ear size, and height. An appropriate application of N to correct the deficiency, will less likely affect lodging as will an oversupply of N. A fine line exists between under and over supply of N. A long-term, comprehensive soil testing program will help nutrient management decisions.

Correcting for phosphorous (P) deficiencies may improve root development, which increases anchor strength. Potassium (K) additions to deficient soils reduces the lodging, likely due to improved turgor regulation. Excessive additions of P and K no longer improve lodging resistance, but should not cause lodging. Oats may be an exception with high P rates.

Management. It is too simplistic to merely look at N reductions to prevent lodging. In fact, N deficiency may be reducing yield and not lodging. Recognizing within each field the actual cause of lodging will provide better management strategies.

1. **What type of lodging is occurring**? Is the stem bending, roots breaking or roots slipping through the soil? If it's the stem, where is it bending at? If it appears to be anchorage failure was it from disease, poor rooting, or soil structure changes?
2. **Fertility Management**. Test soils to ensure nutrient applications are within a reasonable amount. Ensure K is adequate and that there is sufficient P early on for root development. If N appears to be a problem, try incorporating split N applications to reduce early heavy vegetative growth. This will unlikely increase yield, but may help maintain higher protein levels.
3. **Seeding rates**. Get thousand seed weights performed when you get germination tests and sow seeds based on plants per square foot rather than bushels per acre. A target seeding rate of around 35 plants per ft^2 for wheat and 25 plants per ft^2 for barley emerged are reasonable. Perform spring plant counts to determine actual emergence rates. Often what we think emerges is not what actually emerges.
4. **Tillage**. Consider direct seeding or reduced tillage on your farm if lodging has been problematic. The benefits after 5 or 6 years of direct seeding will be worthwhile. If plant roots are slipping through the soil due to tillage, try land rolling the soil before plants are at growth stage 20. Reduce tillage to times when absolutely necessary. Increase packer pressure if possible.
5. **Genetics**. If you suspect plant architecture is the causal factor for lodging in a particular field, consider choosing different varieties. Select plants with a proven history of lodging resistance, or at least select plants with a shorter stature, or shorter or awnless varieties.
6. **Disease**. Appropriate seed treatments for the diseases in your field will help prevent disease induced lodging.

Conclusion: It is important to carefully evaluate lodging causes and to not blindly attribute lodging to Nitrogen rates only. Low N may rob yield unnecessarily, without reducing lodging incidence. If you have lowered N rates substantially and lodging still occurs, carefully consider the total farm management strategy.

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