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Signs of Drought Stress in Soybean

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We are in the onset of a substantial drought in various regions of Indiana with rapid expansion across the state. Drought-stressed soybeans are usually not as visually dramatic as drought-stressed corn. Soybean's response to drought (heat and water stress) occurs at various levels including cellular structures, metabolic processes, and physiological development. As you can imagine, these are interrelated with direct and indirect effects on visual appearance. I would like to describe and show some of the most common signs of drought stress in soybean during the early season.

The first signs of drought stress in soybean is difficult to see from the roadside, and it is somewhat challenging to assess in the field. Leaf expansion rates are reduced under drought stress, so **leaf size tends to be smaller** under drought conditions. This may seem like a natural conclusion, but it is difficult to pick up on it early. We usually notice this sign of drought stress after several weeks have passed by and the soybeans do not appear to be growing (Figure 1). In fact, the early season stress will cause the soybean to shift more of its energy and efforts to root development with limited vegetative growth (Figure 2).

The more obvious sign of soybeans responding to drought stress is **leaf flipping** (Figure 3). This is somewhat analogous to corn rolling. Soybeans will literally flip the leaves to reflect more sunlight by exposing the silver-green underside. This conserves water by reducing the temperature stress experienced by the plants. You can think of it as soybeans' version of a windshield reflector for your car. Secondly, water is conserved by reducing the photosynthetic rates (less absorbed radiation). The dark green topside of the leaves absorbs more sunlight, which would require water to satisfy photosynthesis (Figure 4). One indication of the severity of the drought stress is the occurrence and the duration of the leaf flipping. In other words, if it occurs early and often the severity is worse.

Severely drought-stressed soybeans will progress to "**leaf clamping**" (Figure 5). The outer leaflets of the trifoliate will start to close or clamp together to reduce the leaf area exposed to sunlight and to reduce water loss. In severe cases, the center leaflet (of the three leaflets that make up the trifoliate) will be sandwiched between the outer leaflets as they clamp down. The leaflets of young trifoliates (leaves emerging from the terminal bud) will even fold on themselves like a taco (Figure 6). Leaf flipping and leaf clamping can occur throughout the growth of soybeans from emergence to seed fill.

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Drought stress can cause young soybeans (V3 to V5) to initiate flowering and reproductive growth sooner than is typically expected. The plant is moving into survival mode with limited resources available for vegetative growth (Figure 7). Implications of early season drought can be long-lasting or short-lived in soybean. Many of our soybean fields are limited due to drought because of reduction in photosynthetic factories (vegetative biomass) in addition to limited nodal production. Fortunately, soybean has a larger grace period than corn in terms of the drought response. We may be short on node production, but we still have an opportunity (with return of moisture) to make up ground in yield through flowering, pod development, and seed fill.

Figure 1. The difficulty of determining drought stressed soybeans from the windshield. This looks like a “normal” field of soybean, but the field has looked like this for several weeks.

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Figure 2. Soybean with limited vegetative growth due to drought stress. This is a close-up of the same field in Figure 1. The leaves are smaller than normal resulting in limited row closure. Vertical growth was limited and soybeans were shorter than the corn stalks that were 8 to 10."

Figure 3. Field of soybeans flipping their leaves to the underside that is a silver-green.

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Figure 4. The silver-green underside of the soybean leaves are reflecting sunlight to conserve water, while the dark-green topside is absorbing more sunlight.

Figure 5. Young soybeans flipping leaves and beginning to clamp.

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Figure 6. Limited leaf expansion, flipped leaves, and clamped leaves of severely drought stress soybeans. Notice the drought-severity of the volunteer corn.

Figure 7. Early flowering of soybean due to drought stress. These soybeans are at V3 (3 expanding trifoliates). The first flower is at the first trifoliate, which is only a few inches above the soil. If the flower is retained and the pod develops and fills out, this will also be the height of the first pods at harvest. Notice the corn stalks compared to the soybean's height.