SeedSCOOP

DROUGHT EFFECTS ON NITROGEN AVAILABILITY IN CORN

Drought and nitrogen (N) can affect the growth and development of corn either separately or in combination. Drought can have a strong impact on plant nutrient relations. Water and N stresses under field conditions are common and understanding the interaction of these two inputs is important for efficient corn production.

Nitrogen Uptake by Corn

Nitrogen is the most important nutrient in corn production. Corn takes up N from the soil throughout its active growth. The majority of N is taken up during vegetative growth with about two-thirds of the total N uptake completed by flowering or the R1 growth stage of corn. The highest rate of N uptake occurs during rapid vegetative growth when corn is in the V10 through V14 growth stages. Nitrogen uptake prior to corn flowering is critical to support ear shoot development, kernel number, and potential kernel size. During reproductive growth or post-flowering, corn takes up the remaining of its total N and uses it for grain development. [1]

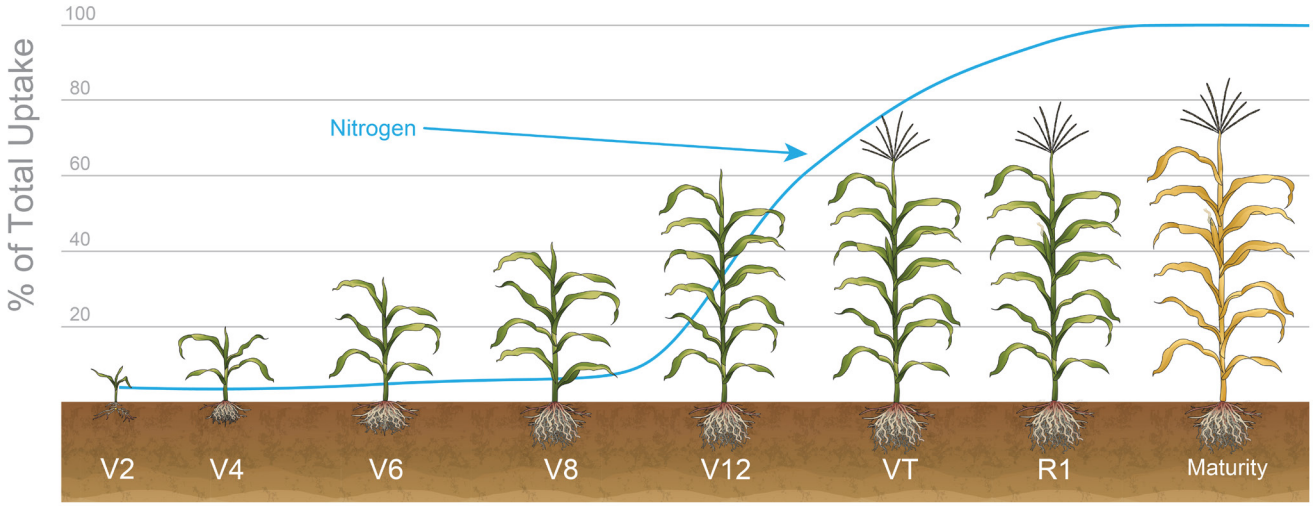

Figure 1. Uptake of nitrogen by corn.

Drought Effects on Corn

Drought is one of the most common environmental stresses of plants and can negatively impact their growth, development, and reproduction. The amount of corn yield loss that occurs during dry weather depends on what stage the corn is in and how severe the dry conditions become.[2] Drought conditions early in the season from emergence to the V8 corn growth stage can impact early root development and reduce plant and leaf size affecting photosynthesis. Drought occurring during the V8 to V16 growth stages can reduce corn ear size and potential yield. Silking is the most sensitive stage for drought stress to occur resulting in severe yield reductions due to incomplete pollination and the loss of kernel number. Drought during the reproductive growth of corn affects kernel weight with dry conditions immediately following silking having the largest impact. Drought later in reproductive growth is less damaging but can hasten corn maturity.

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Drought and Nitrogen Uptake by Corn

Drought can decrease N uptake from soil and reduce the concentration of N in plant tissue.[3] Nitrogen uptake in dry soil is reduced primarily by the inhibition of root growth along with a decrease in N transport in the soil to the root surfaces. Severe drought can induce root shrinkage and loss of soil-root contact. Nitrogen uptake ability by corn recovers quickly after rewetting of the soil regardless of the length of drought conditions. The recovery of N uptake ability occurs through established older roots as well as the production of new roots. Mild drought stress can initially increase root growth, but severe and long-lasting drought can decrease root growth. With moderate drought stress during corn vegetative growth, rooting depth can increase, allowing more efficient uptake of water and nutrients from deeper within the soil profile. The uptake of N under dry conditions is also increased when soil N fertility is high. Nitrogen deficiency symptoms generally do not appear on corn under drought conditions with high N soil levels.

The response of corn to soil water availability is strongly dependent on N levels in the soil. Nitrogen deficient corn is more sensitive to water deficits than N sufficient corn. Both water and N stress can lengthen the time from emergence to tasseling and silking. Nitrogen stress delays tasseling, whereas water stress delays both tasseling and silking. Severe water stress in combination with low N reduces the amount of applied N taken up and accumulating in the crop. Reduced grain yield caused by drought is exacerbated by N deficiency. When N supply is limited, grain yield is more associated with N deficiency than drought stress, but with adequate N supply, drought stress is the main limiting factor.[4]

Water and N inputs must be closely matched so efficient utilization of each input is realized. For a corn crop to take advantage of soil N, adequate water must be available. Low soil N substantially reduces leaf area and photosynthesis as a result. Total biomass, seed weight accumulation, N uptake and their respective accumulation rates all show interactions with water and N. With more severe water stress, the effects of low soil N becomes less evident.[4] Agronomic measures like irrigation frequency and timing of fertilization are important considerations to maintain nutrient uptake ability by plants growing under drought conditions.[3]

Corn products selected today can be planted at higher populations and are more efficient in taking up N compared to older products.[5] They are able to maintain yield in the face of plant density stress and N stress. They can take up more N during reproductive growth, making it more advantageous to reserve some N applications for later in both optimum and adverse growing conditions. Drought-tolerant corn products can help reduce the risk of yield loss when drought occurs. DroughtGard® Hybrids corn products can help plants maintain growth when water is scarce, helping to support yield opportunity. They are selected to offer high yield potential in well-watered conditions and to help protect against the risk of yield loss when drought stress occurs.

Sources

[1] Bender, R., Haegele, J., Ruffo, M., and Below, F. 2013. Modern corn hybrid's nutrient uptake patterns. Better Crops volume 97, number 1.

[2] Heiniger, R. 2017. The impact of early drought on corn. North Carolina State University Extension. https://corn.ces.ncsu.edu.

[3] Buljovcic, Z. and Engels, C. 2001. Nitrate uptake by maize roots during and after drought stress. Plant and Soil 229: 125-135.

[4] Bennett, J., Mutti, L., Rao, P., and Jones, J. 1989. Interactive effects of nitrogen and water stresses on biomass accumulation, nitrogen uptake, and seed yield of maize. Field Crops Research 19: 297-311.

[5] Purdue University. 2016. Modern corn hybrids more resilient to nitrogen stress, crowded plant conditions. ScienceDaily. https://www.sciencedaily.com.

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