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Does drought favor crops or weeds?

Climate change is projected to increase the frequency of agricultural droughts in the Northeast[1]. This trend will be driven by variable rainfall and rising temperatures, which cause water to evaporate more rapidly out of soil and plant leaves. Severe agricultural droughts can lead to catastrophic crop yield losses, threatening grower livelihoods and food security. In the Northeast, field crops such as corn or soybean may be particularly vulnerable to drought because they are typically not irrigated[2]. Agricultural weeds also pose a significant threat to field crop yield. For example, potential corn yield losses due to weeds in the United States and Canada average 50%[3]. This article explores why drought may either increase or decrease the impact of weeds on annual rain-fed field crops.

Although all plants require water, plant species vary in their resistance to drought. Some agricultural weeds, such as common chickweed and henbit, require moist soil and are likely to die under drought conditions[4]. Unfortunately, many common agricultural weeds are more drought resistant than crops[4] . These weeds may be especially problematic under drought conditions. Both crops and weeds can achieve drought resistance in several ways: completing their life cycles before the drought begins, avoiding dehydration under drought conditions, tolerating dehydration with minimal damage, and/or recovering well after rehydration.

The following traits are key determinants of drought resistance in crops and weeds (Figure 1):

1) *Extensive root systems*. Many weeds have large or deep root systems, enabling them to resist drought and reduce water availability to crops[4]. For example, field bindweed roots can extend tens of feet into the soil profile[5].

2) *C_4 photosynthetic pathway*. Plants generally perform photosynthesis in one of two ways: the C_3 pathway or the C_4 pathway. Most species use C_3 photosynthesis, the simpler pathway. C_4 photosynthesis enables plants in hot and dry environments to maintain high photosynthetic rates while partially closing stomata, which are small pores in plant leaves[6]. Closing stomata limits CO_2 entry but also limits water loss through the leaves. Under hot and dry conditions, C_4 weeds such as pigweeds may outcompete C_3 crops such as soybean[7]. Conversely, C_4 crops such as corn may outcompete C_3 weeds.

These traits, in combination with other factors, determine how drought and weeds interactively affect crop yield. When drought-resistant weeds are present, drought conditions may exacerbate yield losses due to weeds. In this situation, it is particularly important to maintain good weed control throughout the growing season. Drought can lead to challenges including reduced herbicide efficacy[8]. Drought can also increase mortality of uprooted weeds after mechanical operations[4], although growers should consider reducing soil disturbance during severe droughts[9]. In the long term, growers may select drought-resistant crops or varieties, increase spatial or temporal crop diversity, and maintain soil health with tactics like cover cropping. Such practices can support both climate resilience and sustainable weed management.

As climate change increases the frequency of agricultural droughts, drought-resistant weeds such as Palmer amaranth, common ragweed, and large crabgrass[4] are likely to become more dominant in agricultural weed communities. Growers can minimize risk by adopting integrated approaches to weed management that combine diverse tactics. Integrated weed management programs should be regularly adjusted to tackle emerging threats including drought-resistant weeds.

Figures

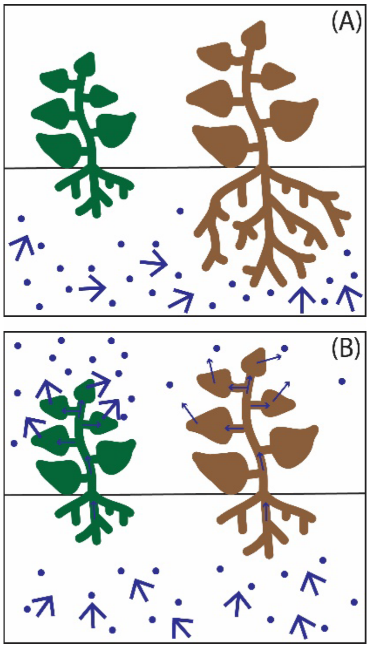

Figure 1. Two reasons that drought conditions might favor drought-resistant weeds (brown) over drought-sensitive crops (green). **(A)** When weeds have more extensive roots than crops, they can access water stored deep in the soil profile. Examples of deep-rooted weeds include field bindweed and Canada thistle. Blue arrows indicate the direction of water movement. **(B)** To gather enough atmospheric CO_2 to achieve high rates of photosynthesis, crops with the C_3 photosynthetic pathway must open their stomata (leaf pores) wide. Large amounts of water are lost through these open stomata. Weeds with the C_4 pathway can achieve high rates of photosynthesis while keeping stomata more closed. Examples of C_3 crops include soybean and wheat, while C_4 weeds include pigweeds and nutsedges. Some weeds are less drought resistant than deep-rooted or C_4 crops such as corn. However, many major agricultural weeds are more drought resistant than major crops and likely to present increasing management challenges under climate change. Original artwork.

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