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Can Nitrogen Rescue a Flooded Soybean Crop

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In a bean pod

- **Soybean plants are sensitive to excess water**
- **Soybean can survive short-lived flooding events**
- **Mitigation practices for flooded soybeans are limited**
- **Applying nitrogen as a broadcast fertilizer may help soybean plants recover**

Introduction

The spring of 2024 brought many challenges to Wisconsin soybean growers, including heavy precipitation and late planting (Fig. 1). Many soybean fields were unplantable until late May, and some of those that were planted were later underwater. Soybean seeds or plants submerged for several weeks are usually not salvageable. However, in fields where temporary flooding occurs and water recedes within a few days or over a week, soybeans can survive, continue to grow, and produce a crop. Yield losses are usually not noted for soybeans submerged for less than 48 hours. These soybeans may be injured and not produce high yields, but if the field remains wet, replanting may not be an option either.

Several factors can dictate how well a particular soybean field will tolerate saturated soils and flooding. These include the growth stage, the rate of soil drying, soil texture, subsurface drainage, soil temperature, and the duration of the flooding. In addition to limiting oxygen to the growing soybean roots, flooding can cause root diseases to flourish, leach nitrogen from the soil, and restrict the uptake of essential plant nutrients.

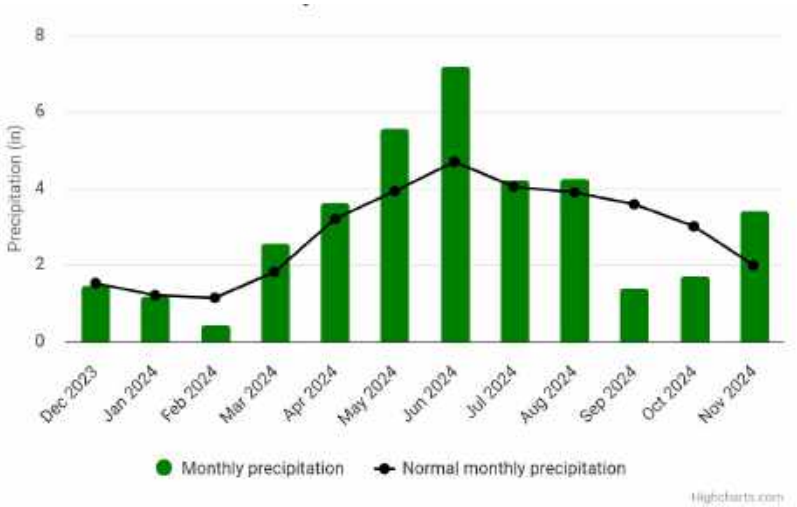

Figure 1. WI statewide precipitation and normal monthly data from Dec. 2023 to Nov. 2024.

Funding for this project was provided by the Wisconsin Soybean Marketing Board.

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Our approach
Since flooding can remove nitrogen (N) from the soil through leaching, and oxygen is essential for general soybean growth and nitrogen fixation activities on the roots, we hypothesized that additional N in the form of a broadcast fertilizer might benefit soybeans that have experienced flooding or saturated soils. These soybeans may lack the N needed for optimal growth from both the soil and the nitrogen fixation process.

Research trial
A replicated trial to test the effects of broadcast nitrogen (N) fertilizer on soybeans stressed by flooding and saturated soils was initiated in July 2024. A soybean field planted in 15-inch rows on May 6, 2024, at the Arlington Agricultural Research Station in Arlington, WI, which experienced significant flooding shortly after planting, was selected (Image 1). The field had a very gradual slope, resulting in areas where soybeans were underwater for extended periods and areas with only saturated soil conditions.

Main plots consisted of replicated strips of urea (46-0-0) fertilizer (30 lbs N/acre) broadcast on July 8, 2024, to V6/R1 growth stage soybeans using a DJI T40 drone equipped with a broadcast spreader (Image. 2 and 3). The entire field was imaged several times during the season using a DJI Mavic 3M multispectral drone equipped with a 4/3 CMOS 20MP RGB camera and four 5MP multispectral cameras (green, red, red edge, and near-infrared) to scan and analyze crop growth. This drone also carried a built-in sunlight sensor to capture solar irradiance. NDVI (normalized difference vegetation index) data were calculated from the field images.

Image 1. Flooded research soybean field on July 8, 2024.

The main plot of broadcast N was divided into subplots of 30 ft. x 25 ft. to encompass a spectrum of flooding intensities. Grain yield data were determined for each plot in October.

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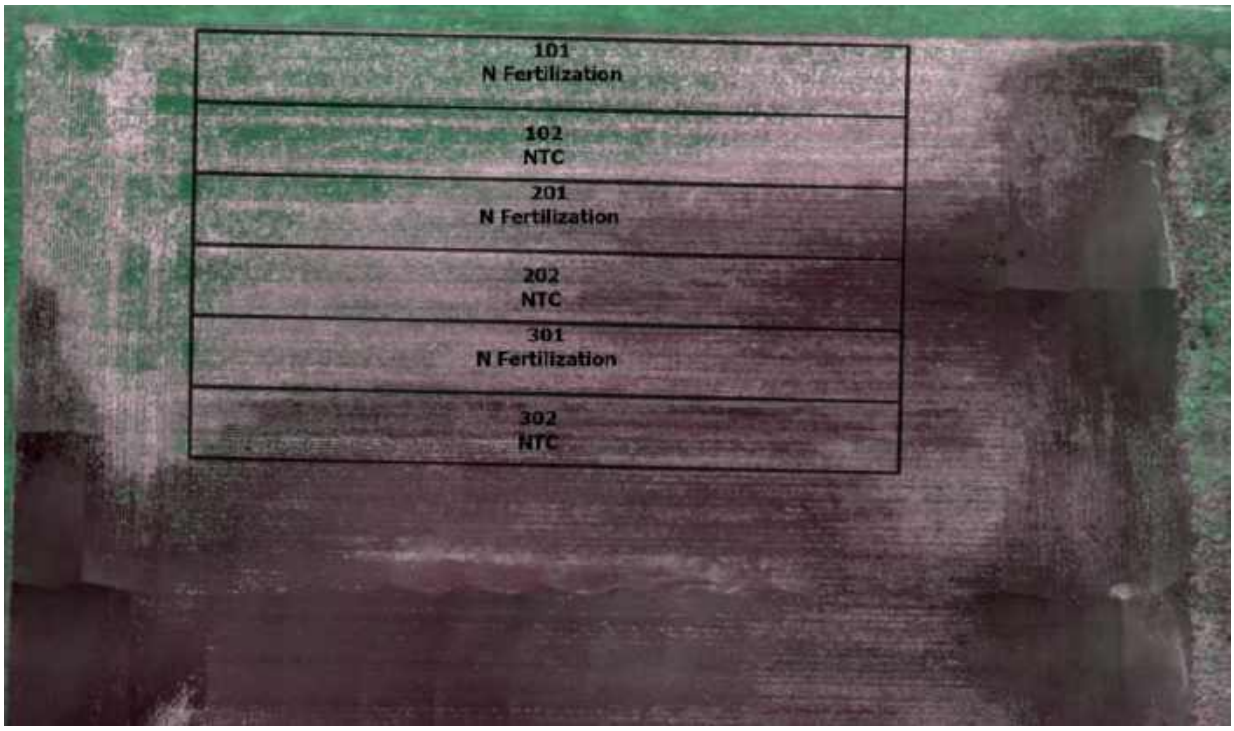

Image 2. Orthomosaic on July 8, 2024 of flooded soybean field with main plots of broadcast urea fertilizer shown.

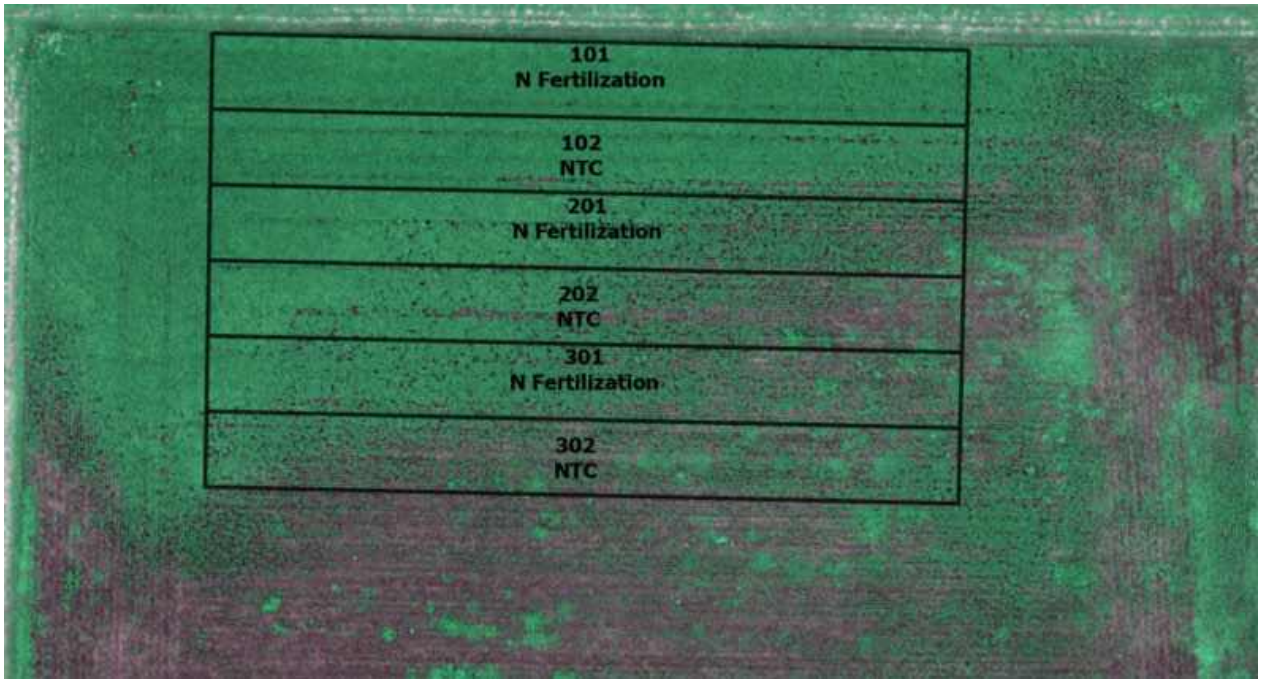

Image 3. Orthomosaic on Aug. 30, 2024, of flooded soybean field with main plots of broadcast urea fertilizer shown.

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Results

Analysis of yield data showed a 17% increase in yield for the N fertilization treatment over the non-treated control across all ranges of flooding (Fig. 2).

NDVI, a measure of plant health and biomass, was also higher in the N-treated plots compared to the non-treated control on three dates in July and August (Fig. 3). This can partially explain the yield difference due to N fertilization.

Managing flooded soybean fields is challenging due to limited management options. If flooding occurs early in the season and the soil dries enough to support machinery, replanting can be an option. Cultivation can also be beneficial by aerating the soil. To reduce artificial stress on the crop, delay any foliar applications that may injure the plants. Later season flooding is even more difficult to manage. Options include harvesting non-flooded portions of the field first and then waiting for wet spots to dry up. Additionally, there is a risk that grain quality in flooded soybeans may be compromised. Inspect grain from affected areas before mixing it with good grain.

Our study is for one year only, and flooding can affect your fields in various ways. Use good management practices on all soybeans to make the best decisions for your situation.

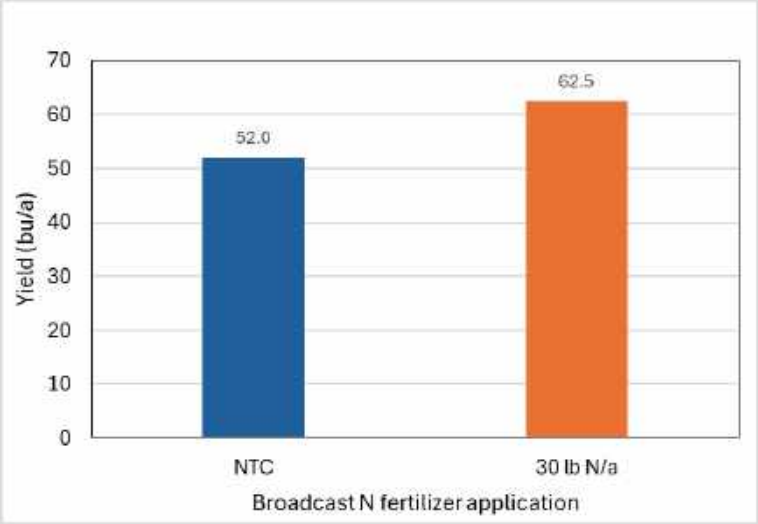

Figure 2. Effect of fertilizer N on grain yield of flooded soybean. P<0.05

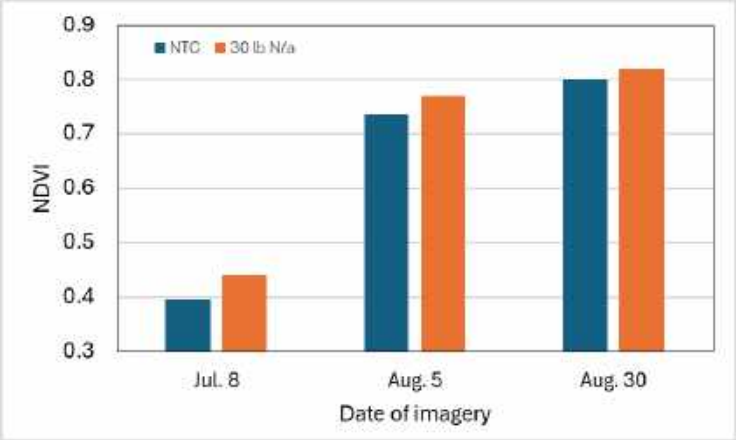

Figure 3. Effect of fertilizer N on NDVI of flooded soybean.

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