Science Societies

# Nitrogen management for industrial hemp fiber production

## Cultivar differences in biomass response to nitrogen application rates

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*Photo by Kenlee Scott.*


A three-year Florida study examined the effects of nitrogen fertilization on two industrial hemp cultivars grown for fiber production. The results highlight the importance of matching nitrogen management to cultivar characteristics and growing conditions to optimize biomass yields.

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Industrial hemp (Figure 1) is one of the oldest and most widely cultivated plants across the globe (James et al., 2023). In the United States, however, hemp production was restricted for decades under the Federal Marijuana Tax Act of 1937, which classified hemp as a "Schedule I Controlled Substance." (Ekren et al., 2023). Interest in hemp production was renewed with the passage of the 2014 farm bill, which allowed states to establish hemp research and pilot programs (James et al., 2023). The development of cultivars with low Δ-9 tetrahydrocannabinol (THC) concentrations further distinguished industrial hemp from marijuana, which typically contains 3 to 15% THC. In

2021, the USDA finalized regulations requiring compliance with THC limits, including both Δ-9 THC and tetrahydrocannabinolic acid (THCA) (USDA-AMS, 2021).

***Figure 1.*** *Industrial hemp in a growing field in West Florida. Photo by Nkem Nwosu.*

Industrial hemp is a short-day, annual herbaceous plant with many commercial applications. Fiber hemp, in particular, is valued by the textile and fiber industries because of its high cellulose content. In spite of its numerous uses, there is still limiting information on the appropriate nutrient management program for optimizing growth and fiber yields of industrial hemp.

Nitrogen (N) is the most limiting nutrient influencing crop production, including industrial hemp. This is because N is crucial for growth and other essential metabolic processes that contribute to the synthesis and transfer of energy in plants (Laleh et al., 2021). Growers have been faced with the issue of establishing an optimal N rate for advancing industrial hemp fiber production. The leaves of industrial hemp are very

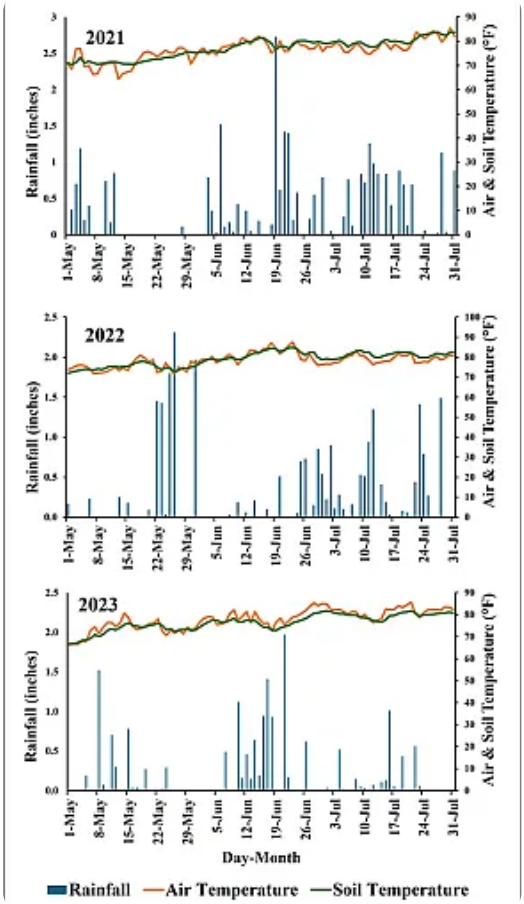
sensitive to N supply, and studies have observed that hemp usually amasses high N demand in the initial growth phase for emergence and plant height optimization (Papastylianou et al., 2018).

While studies by Ekren et al. (2023) have observed a 48, 65, and 57% increase in plant height, stem yield, and fiber yield, respectively, when raising N rates from 0 – 250 lb N/ac, the effect of N on industrial hemp growth and fiber productivity has been quite complex and multidirectional.

Researchers have observed that the effect of N on industrial hemp depends on rainfall intensity and distribution, temperature, soil type, location, cultivar type, and the primary purpose of production (fiber, flower, or seeds).

Studies that evaluate the response of commonly grown fiber-type industrial hemp cultivars to N rate under southeastern U.S. conditions are very limited. The objective of this study was to evaluate six N rates on two hemp cultivars under Florida conditions.

## How was it done?



A three-year (2021–2023) study was conducted at the University of Florida's West Florida Research and Education Center (WFREC) in Jay, FL. The area is characterized by a humid subtropical climate. The soil type was sandy loam, possessing good drainage and nutrient retention. Weather data was obtained from the Florida Automated Weather Network for 2021–2023 (Figure 2). A factorial in a randomized complete block design with four replications was adopted for this study. The study evaluated six N rates (0, 50, 100, 150, 200, and 250 lb N/ac) on two industrial hemp cultivars (NWG-2730 and IH Williams).

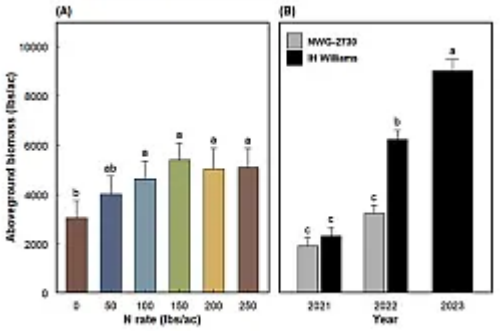
***Figure 2.*** *Weather data of the study location during period of evaluation (2021–2023).*

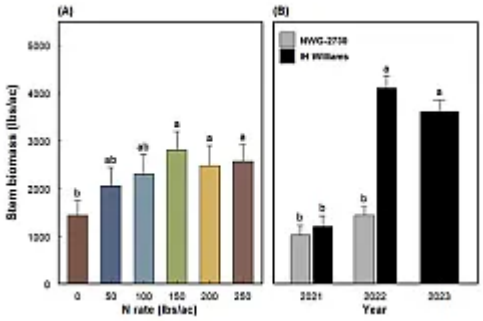
The field was disked and subjected to strip tillage prior to planting. Industrial hemp was seeded each year using a six-row cone planter to a spacing of 7.5 inches. The N fertilizer treatment was applied using urea, and to maximize then use efficiency, application was done in two splits. The first split was a uniform application of 50 lb N/ac at two weeks after planting, while the remainder of each N rate was applied at four weeks after planting, respectively. Other agronomic management practices like base fertilization, irrigation, and weeding were conducted as required to maximize treatment effect on the evaluated parameters. Data was collected on aboveground biomass and stem biomass. The holistic process for this evaluation is presented in Figure 3.

***Figure 3.*** *Workflow of the evaluation–from planting to nitrogen application, to the mature fiber hemp, to fiber harvest, showing aboveground biomass and the stem biomass. Photo by Nkem Nwosu.*

## What do the results tell us?

The aboveground biomass and stem biomass are two industrial hemp fiber yield indicators. Studies have observed that the higher the aboveground and stem biomass weight, the greater the resulting fiber yield. From the results, we discovered that total biomass and stem biomass were affected by the year × cultivar interaction, with no cultivar effect in 2021 but much high yield with cultivar IH Williams compared with cultivar NWG-2730 in 2022 (Figures 4 and 5). Although there was an initial increase in aboveground biomass, there was no significant increase beyond 100 lb N/ac. In a similar vein, there was no significant increase in stem biomass after 50 lb N/ac. Stem and total biomass were more with fertilizer N applied at 150 lb/ac compared with 0 lb/ac.




*(Left)* ***Figure 4.*** *Response of total aboveground biomass to (a) nitrogen rate and (b) cultivar × year effect. (Right)* ***Figure 5.*** *Response of stem biomass to (a) nitrogen rates effect and (b) cultivar × year effect.*

Further, the results showed that aboveground biomass and stem biomass were 38 and 41% higher, respectively, in cultivar IH Williams than cultivar NWG-2730. This was due to the high-yielding genetic capacity of IH Williams as observed in its higher plant

height and stem diameters (Nwosu et al., 2026). Although IH Williams is a dual-purpose industrial hemp cultivar, it is primarily grown for fiber production, while NWG-2730 is primarily grown for seeds. We observed a similar response in the coupling effect of N rate × cultivar on aboveground biomass and stem biomass, which is consistent with observations in Vermont (Darby & Sullivan, 2024) and Oregon (Viskovi□et al., 2023).

Our results indicate that IH Williams could result in more fiber yield than NWG-2730 under Florida conditions, and the optimal N rate for aboveground biomass and stem biomass, respectively in industrial hemp was not dependent on the cultivar type.

However, the significant interaction of N rate × year (with the highest peak in 2023) denotes that the effect of N rate on aboveground biomass and stem biomass was dependent on the yearly weather patterns (Figure 2).

## Conclusions

Considering the findings from this study, we can conclude that the performance of the incremental changes in N rates on the two commonly cultivated industrial hemp cultivars evaluated are similar. The study also concludes that cultivar IH Williams will give more fiber yields than NWG-2730, while the latter will do better for seed yield. The study also concludes that weather patterns play a crucial role in dictating the level and direction of influence of N rates on industrial hemp. The study concludes that generic N recommendations that do not consider the hemp cultivar type, location, and prevailing environmental conditions (rainfall, temperature, and soil type), should be avoided.

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**Dig deeper**

Nwosu, N. J., Upadhyaya, Y. R., Ajani, O., Dar, E. A., Brym, Z., Sharma, L., & Singh, H. (2026). Growth and biomass response of industrial hemp (*Cannabis sativa* L.) cultivars to nitrogen rates for fiber production. *Crop Science*, *66*, e70258. **https://doi.org/10.1002/csc2.70258**

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**1. Which two industrial hemp cultivars were evaluated in the study?**

a. NWG-2730 and IH Williams.

b. IH Williams and Fedora 17.

c. NWG-2730 and Futura 75.

d. Fedora 17 and Futura 75.

**2. How was nitrogen fertilizer applied during the experiment?**

a. As a single application before planting.

b. In weekly applications throughout the season.

c. In two split applications.

d. Through irrigation water.

**3. What happened to aboveground biomass as nitrogen rates increased?**

a. It increased initially but showed no significant gain beyond 100 lb N/ac.

b. It increased initially and then continued rising significantly through 250 lb N/ac.

c. It increased initially but began declining significantly above 100 lb N/ac.

d. It increased initially but reached its highest value at 50 lb N/ac.

**4. Which cultivar produced greater aboveground and stem biomass in the study?**

a. NWG-2730.

b. IH Williams.

c. Fedora 17.

d. Futura 75.

**5. The significant nitrogen rate × year interaction indicated that hemp response to nitrogen depended largely on**

a. planting density.

b. seed source.

c. harvest timing.

d. weather conditions.

*This quiz was drafted with AI assistance and reviewed by the editorial team for accuracy and appropriateness.*

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