increasing ABA during bulking to promote C allocation into roots. Moderate N with medium planting density (MDMN) increased yield by 15%-25% by accelerating cambial ring formation and shifting gene expression from nitrogen-intensive defense to carbon storage (Zhao et al., 2026). Early N application at or before planting promoted non-structural carbohydrate translocation from vines to roots, increasing storage root number and fresh yield (Dong et al., 2025). Delayed N supply impaired this translocation, accumulating carbohydrates in vines instead of roots. K supply improved N transport rate from 9.8% to 20.1% and root N distribution from 50.3% to 59.3%, enhancing root dry matter allocation (Wang et al., 2020). A rate of 50 kg N/ha produced a better harvest index and higher nitrogen use efficiency (NUE) than elevated rates (Higashikawa et al., 2025).

7.2 Genotype-specific responses to nitrogen

Sweet potato cultivars differ markedly in N tolerance and use efficiency. The N-tolerant cultivar Xushu 32 (X32) absorbed less N and distributed more N to developing storage roots than the N-susceptible Jishu 26 (J26) under increasing N rates (Duan et al., 2021). X32 storage root development was sensitive only to the highest N rate (400 mg/kg), while J26 was sensitive to both 200 and 400 mg/kg. Under high N and normal moisture, J26 exhibited root lignification, reduced starch accumulation, and limited assimilate transport, whereas X32 was largely unaffected (Duan et al., 2023). Among five cultivars evaluated under varying N concentrations, Yao et al. (2020) pointed out that SS19 and GS87 showed greater tolerance to low N and produced higher storage root yield at 30 days (Yao et al., 2020). Split N application increased yield by 16.6-19.0% across two cultivars (Xushu 22 and Shangshu 19), though optimal split ratios may depend on cultivar and rainfall regime (Du et al., 2019). N-tolerant cultivars are recommended for fertile plain areas because they form storage roots earlier under high N conditions (Duan et al., 2021).

Cultivar identity strongly influences starch and root trait responses to N. In Jishu 25, 75 kg N/ha produced the highest storage root yield, starch yield, and dry matter accumulation exceeding one ton per mu, while 150 kg N/ha reduced starch yield through lower root yield despite increased amylose content (Duan et al., 2019). For cultivars Xushu 22 and Xushu 28, N rates of 60-120 kg/ha did not greatly decrease starch content, but 180 kg N/ha significantly reduced storage root yield. In contrast, starch levels in cultivar Rainha Branca decreased with increasing urea, with the lowest starch percentage at 460 kg/ha.

Under high N, X32 downregulated lignin and flavonoid synthesis genes, redirecting carbon flux toward starch metabolism and reducing lignification (Duan et al., 2021). J26, however, showed downregulated AGPa, AGPb, GBSSI, and SBEI expression under high N and normal moisture, inhibiting starch synthesis (Duan et al., 2023). Purple-fleshed sweet potato at northern latitudes showed the highest tuber-to-root mass ratio and leaf C/N ratio at N0, suggesting that N fertilization can constrain productivity in short-season environments (Zekker et al., 2025).

7.3 Precision nitrogen management

Portable chlorophyll meter readings provide a practical tool for in-season N diagnosis. A nitrogen sufficiency index (NSI) threshold of 90% reduced N application rates by 44-66% without negatively impacting storage root yield across three sites in Brazil (Rodrigues et al., 2024). An NSI threshold of 95% increased N application rates without yield benefit, making 90% the recommended diagnostic threshold. Soil nutrient diagnosis underpins rate selection: for Jishu 25, N application of 60-90 kg/ha was based on soil nutrient content, with 75 kg/ha identified as optimal (Duan et al., 2019). Combined NPK fertilization significantly increased storage root yield by 34.8%-53.1% compared with single-nutrient deficiency treatments, and random forest regression identified P accumulation in storage roots as the most important yield predictor (Zhao et al., 2025). Urease and nitrification inhibitors improved NUE and marketable yield, with double-inhibitor treatment producing the highest yield (30,923 kg/ha) and a significant positive correlation between marketable yield and NUE (Kakabouki et al., 2020).

Stage-specific N management models synchronize N supply with developmental transitions from storage root initiation to bulking. Moderate N (100 mg/L) promoted early starch accumulation during the first 35 days, while higher N (200 mg/L) enhanced total non-structural carbohydrate accumulation at 49 days, indicating shifting N