requirements across growth stages (Dong et al., 2025). Split application at basal and 35 days after transplanting prolonged the fast N uptake phase and increased N partitioning to storage roots during middle and late growth stages (Du et al., 2019). The economic optimum N rate (74 kg/ha) was substantially lower than the maximum technical efficiency rate (165.5 kg/ha), providing a basis for site-specific rate calibration (Higashikawa et al., 2025). MDMN treatment accelerated cambial ring formation at 15-30 days after planting and upregulated starch/sucrose metabolism genes, establishing a sink-optimized strategy under high-density, low-input systems (Zhao et al., 2026). Optimal split proportions should be determined according to primary soil fertility, cultivar identity, and rainfall regime, integrating soil diagnosis, plant monitoring, and growth-stage-specific N delivery to achieve high-yield and high-starch production (Du et al., 2019).

8 Concluding Remarks

Current evidence shows that the response of sweet potato to nitrogen is not simply positive or linear. Nitrogen deficiency restricts leaf growth, photosynthetic capacity, and the establishment of the whole-plant carbon source, whereas excessive nitrogen tends to strengthen aboveground growth and causes more nitrogen and dry matter to remain in leaves, vines, and growing points. The storage-root initiation stage is particularly sensitive. Moderate nitrogen supply is generally more favorable for cambial activity and the establishment of effective storage roots, while higher nitrogen levels may delay or reduce early storage-root formation. Once storage roots have been established, however, plant nitrogen demand increases again. Therefore, a moderate nitrogen supply during the early stage followed by demand-based supplementation later is more reasonable than maintaining a high nitrogen level throughout the entire growth period.

For starch production, it is also necessary to distinguish between starch concentration and starch yield. Nitrogen determines not only how much assimilate can be produced by the leaves, but also how efficiently sucrose is transported to storage roots and how metabolic processes involving AGPase, SS, GBSS, SBE, and related enzymes are regulated. Under nitrogen deficiency, starch concentration in storage-root dry matter is not necessarily low, but total starch accumulation at the whole-plant level may still be constrained by limited biomass production. Moderate nitrogen supply is often more favorable for early starch formation and the establishment of storage-root sink strength. Ultimately, starch yield per unit area is jointly determined by fresh storage-root yield, dry matter content, starch proportion, and carbon translocation efficiency.

Several major limitations remain in the current evidence. First, many nitrogen experiments focus only on final yield and do not simultaneously measure cambial activity, lignification, sugar transport, hormonal status, or starch-related enzyme activities. As a result, it is often difficult to determine at which physiological step yield loss actually occurs. Second, nitrogen indices from sand culture, pot experiments, nutrient-solution systems, and field trials cannot be directly converted into one another. For example, a nutrient-solution nitrogen concentration of 100 mg/L cannot be mechanically converted into a field application rate of 100 kg/ha. Genotypic differences are also substantial. Nitrogen-sensitive and nitrogen-tolerant cultivars already show different patterns in NRT expression, root morphology, and nitrogen allocation, meaning that the same fertilization regime may not perform equally well across multiple cultivars.

Similar limitations exist in molecular studies. *IbAMT*, *IbNAC083*, *IbNF-YA1*, *IbNAC22*, *IbSnRK1*, and several other genes have obtained relatively strong candidate or functional evidence, but most studies still focus on individual genes or specific genetic backgrounds. A regulatory network that can fully explain how nitrogen signaling simultaneously alters cambial activity, hormonal regulation, lignification, source-sink transport, and starch granule formation under field fertilization conditions has not yet been established. In particular, nutrient-sensing nodes such as TOR still lack sufficient direct validation in sweet potato storage roots.

Future research should more closely integrate field nitrogen gradients with multi-omics approaches. Rather than simply comparing “high nitrogen” and “low nitrogen”, continuous sampling should be conducted before storage-root initiation, during initiation, during rapid bulking, and during the period of rapid starch accumulation. At each stage, root NO_3^-, NH_4^+, sugars, organic acids, amino acids, hormones, and starch structure should be