number of storage roots per plant remained lower than those under 100 mg/L nitrogen when adventitious-root differentiation was largely complete (Dong et al., 2022). This suggests that once the early opportunity for storage-root initiation is missed, additional nitrogen supplied later cannot fully compensate for the loss.

The form of nitrogen supplied can also influence root differentiation. A field experiment comparing different nitrogen sources at 60 kg/ha showed that ammonium nitrogen altered the expression of IbEXP1, Ibkn1, and Ibkn2, accompanied by changes in GA_3 and zeatin riboside (ZR) levels and in the activities of enzymes associated with lignin biosynthesis. Importantly, these effects shifted with developmental stage. A certain degree of vascular tissue development during the early stage may help establish an effective transport system, whereas persistently high levels of lignification at later stages can restrict the expansion of parenchymatous tissues (Meng et al., 2022). Therefore, it is not accurate to interpret storage-root development simply as requiring the suppression of all lignin formation. Timing remains a key factor.

3.2 Effects of nitrogen on storage root bulking

The situation changes once storage roots have already been initiated. At this stage, new cells must continue to form, existing cells must expand, and large amounts of carbohydrates must be imported into the developing storage roots. An appropriate nitrogen supply helps maintain both leaf and root activity. The main problem arises when nitrogen is excessive. Under high nitrogen conditions, newly accumulated dry matter is more likely to remain in stems and leaves, while the number of storage roots and individual root weight may initially increase and then decline. In a field experiment examining nitrogen-potassium interactions, Shu et al. (2024) also observed that vine length continued to increase with increasing nitrogen application, whereas the number of storage roots per plant, fresh storage-root weight, and dry storage-root weight generally showed an initial increase followed by a decline.

Data from split nitrogen application further illustrate that the timing of nitrogen supply can be as important as the total amount applied. Compared with the conventional practice of applying 100 kg N/ha entirely as basal fertilizer, reducing total nitrogen input by 20% and applying 40% as basal fertilizer and another 40% at 35 days after transplanting increased the two-year average number of storage roots by 12.3%, individual storage-root weight by 10.2%, and final yield by 22.1% (Du et al., 2020). In this case, yield improvement was not achieved by increasing the total nitrogen rate. On the contrary, less nitrogen was applied. The higher yield was mainly associated with better synchronization between nitrogen supply and crop demand.

3.3 Regulation of biomass allocation by nitrogen

One of the most typical responses to excessive nitrogen is not that the plant fails to grow, but that biomass is allocated to the wrong organs. In a two-season field experiment in Brazil with nitrogen rates ranging from 0 to 300 kg N/ha, the harvest index gradually declined from 0.81, 0.80, and 0.78 to 0.75 and 0.72 as nitrogen application increased (Higashikawa et al., 2025). In other words, additional nitrogen may increase total plant biomass, while reducing the proportion ultimately allocated to marketable storage roots. At the same time, agronomic nitrogen-use efficiency decreased sharply from 51.22 kg/kg at 50 kg N/ha to only 1.69 kg/kg at 300 kg N/ha, while nitrogen recovery efficiency declined from 69.78% to 28.30%.

For this reason, the performance of nitrogen management should be evaluated using storage-root yield, aboveground biomass, harvest index, and nitrogen-use efficiency together. Comparing vine fresh weight alone can easily lead to the mistaken conclusion that a high nitrogen rate is more effective (Du et al., 2019). In sweet potato, moderate restriction of excessive shoot expansion during the early growth stage may sometimes be more favorable for the establishment of a strong storage-root sink (Figure 1).

4 Nitrogen Regulation of Starch Accumulation in Sweet Potato

4.1 Carbon assimilation and sucrose transport

Nitrogen is an essential nutrient for chlorophyll synthesis and the normal functioning of photosynthetic enzymes, and it therefore directly affects the photosynthetic capacity of sweet potato leaves (Dong et al., 2025). Yao et al. (2025) reported that an appropriate ammonium supply (1 mM) during the storage-root bulking stage increased