Nitrogen management is closely linked to this process. When nitrogen supply is insufficient, leaf area development, chlorophyll formation, and photosynthetic capacity can be restricted. Plants may show weak early growth, and less assimilate is consequently available for storage-root development. However, increasing nitrogen supply does not always improve productivity. Sweet potato is harvested for its underground storage organs, and excessive nitrogen can readily shift biomass allocation toward shoots. Vines continue to elongate and leaves maintain relatively high nitrogen levels, whereas storage-root differentiation and carbon translocation to belowground organs may be restricted. Experiments with nitrate nitrogen have also shown that the nitrogen-sensitive cultivar Jishu 26 allocated more nitrogen to leaves and growing points under high nitrate supply, resulting in stronger shoot growth and a greater tendency toward excessive vegetative growth. In contrast, the nitrogen-tolerant cultivar Xushu 32 showed a much more moderate response (Duan et al., 2024).

The key issue in nitrogen management for sweet potato is therefore to achieve an appropriate balance. Nitrogen deficiency should be avoided during storage-root initiation, but the root system should not remain under excessively high nitrogen conditions for an extended period. After storage roots have been established and enter the bulking stage, maintaining sufficient leaf area and sustained photosynthetic activity still requires an adequate nitrogen supply. Dong et al. (2022), for example, found that 100 mg/L nitrogen was more favorable for storage-root initiation, whereas 200 mg/L nitrogen promoted greater biomass accumulation and nitrogen uptake during the subsequent growth stage after storage roots had already formed. Thus, the optimal nitrogen level is not necessarily the same at different developmental stages.

This study mainly examines the effects of nitrogen on storage-root initiation, bulking, biomass allocation, and starch accumulation in sweet potato. It further reviews nitrogen uptake, carbon-nitrogen coordination, hormonal changes, and the regulation of related genes. Particular attention is given to why the same nitrogen level may produce very different responses across growth stages, cultivars, and soil conditions. On this basis, several management approaches with practical relevance are also discussed, including split nitrogen application, combined nitrogen and potassium management, coordination between nitrogen fertilization and irrigation, and plant-based diagnosis of nitrogen status.

2 Physiological Basis of Storage Root Initiation and Development in Sweet Potato

2.1 Formation and differentiation of storage roots

Sweet potato storage roots are not formed simply by the thickening of ordinary fine roots. Among the adventitious roots emerging from the nodes of vine cuttings, only a portion eventually develop into storage roots. The differences are not always obvious during the early stages, but internal tissue differentiation has already begun. Adventitious roots with the potential to form storage roots generally show enhanced cambial activity, followed by the development of active secondary meristematic tissues, an increase in parenchyma cells, and accelerated radial growth. In contrast, some adventitious roots undergo progressively greater lignification, accompanied by pronounced development of vascular bundles and fibrous tissues. These roots are more likely to develop into fibrous roots or pencil roots rather than functional storage roots. In a root-segment comparison experiment, Singh et al. (2021) found that the proximal and distal portions of the same adventitious root had already begun to show different developmental fates within 1-2 weeks after planting. The proximal region exhibited stronger xylem development and lignin deposition, whereas the distal region showed greater starch accumulation at an earlier stage. By the fifth week, these differences had become even more pronounced.

Cambial activity is a key feature of this developmental transition. Transcriptomic analyses of root tissues at different developmental stages have shown that storage-root formation is not controlled by the sudden activation of a single gene. Instead, coordinated changes occur in multiple biological processes, including cell division, cell-wall remodeling, lignin metabolism, and carbohydrate metabolism. An early study covering seven stages of storage-root development detected 5,368 significantly altered genes, including 435 transcription factors. A subsequent transcriptomic study of storage-root bulking identified another 1,312 differentially expressed genes, with genes such as *SBEI*, *ARF6*, *NF-YB3*, and *NF-YB10* showing increasing expression during the bulking process (Wang et al., 2015).