(GBSS) mainly controls amylose synthesis, whereas soluble starch synthase (SSS) and starch branching enzyme (SBE) are primarily involved in the elongation and branching of amylopectin chains (Sheng et al., 2023). Sucrose synthase (SuSy) and UDP-glucose pyrophosphorylase (UGPase) participate in the upstream conversion of sucrose toward starch and play important roles in starch accumulation in storage-root dry matter (Zhang et al., 2017). As storage roots develop, the expression of AGPase, GBSS, and SBE generally increases. Duan et al. (2023) reported that AGPase expression increased in enlarging storage roots, while GBSSI expression rose markedly during the rapid bulking stage.

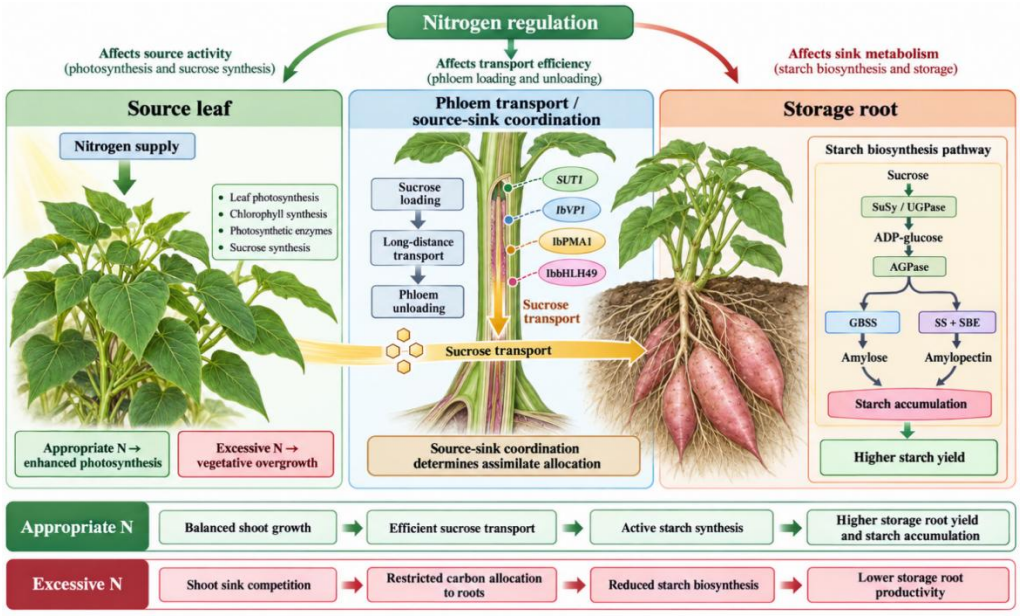


Figure 2 Nitrogen-mediated coordination of source-sink carbon transport and starch biosynthesis in sweet potato
Image caption: Nitrogen availability affects carbon assimilation in source leaves, sucrose loading and long-distance transport through the phloem, and starch biosynthesis in storage roots. Sucrose transported into storage roots is converted through SuSy- and UGPase-associated pathways, followed by AGPase-mediated ADP-glucose formation and subsequent amylose and amylopectin synthesis involving GBSS, SS, and SBE. Appropriate nitrogen supply favors source-sink coordination, whereas excessive nitrogen may divert assimilates toward vegetative organs

Nitrogen management can regulate both the activity of starch-synthesis enzymes and the expression of their related genes. Du et al. (2020) found that reducing nitrogen application to 80% of the conventional rate and applying it in split doses increased starch accumulation by 11.12% through enhanced AGPase and starch synthase activities and upregulation of the corresponding genes. Moderate nitrogen reduction combined with higher planting density increased the expression of *IbSUS2*, *IbSUS5*, *IbAGPS1*, *IbAGPS2*, and *IbAGPL2* from 15 to 45 days after planting, while also enhancing SUS and AGPase activities (Pan et al., 2026). In contrast, excessive nitrogen can restrict starch synthesis by suppressing the expression of *AGPa* and *AGPb* in sweet potato roots. In the nitrogen-sensitive cultivar Jishu 26, high nitrogen under normal water conditions reduced the expression of *AGPa*, *AGPb*, *GBSSI*, and *SBEI*, whereas the nitrogen-tolerant cultivar Xushu 32 was affected to a lesser extent (Duan et al., 2023).

Different nitrogen forms can also produce different responses. Si et al. (2018) reported that amide nitrogen treatment (XN) increased SuSy and AGPase activities as well as starch concentration in potential storage roots, whereas ammonium nitrogen treatment (AN) was more favorable for increasing invertase activity and root number, but had a weaker effect on starch accumulation. Similar patterns have also been observed in potato. In a high-starch potato cultivar, an appropriate nitrogen rate of 150 kg/ha resulted in the highest accumulation of amylose, amylopectin, and total starch. During the early and middle growth stages, the expression of genes such as *AGPP-L*, *GBSSI*, *SBEI*, and *SSIII* generally followed the order N150 > N300 > N0 (Li et al., 2018)..