

also increased potassium, calcium, and nitrogen concentrations in citrus peel and pulp, indicating that external potassium supply can regulate internal nutrient distribution and promote greater nutrient transport toward developing fruit tissues (Figure 1) (Jiao et al., 2022).

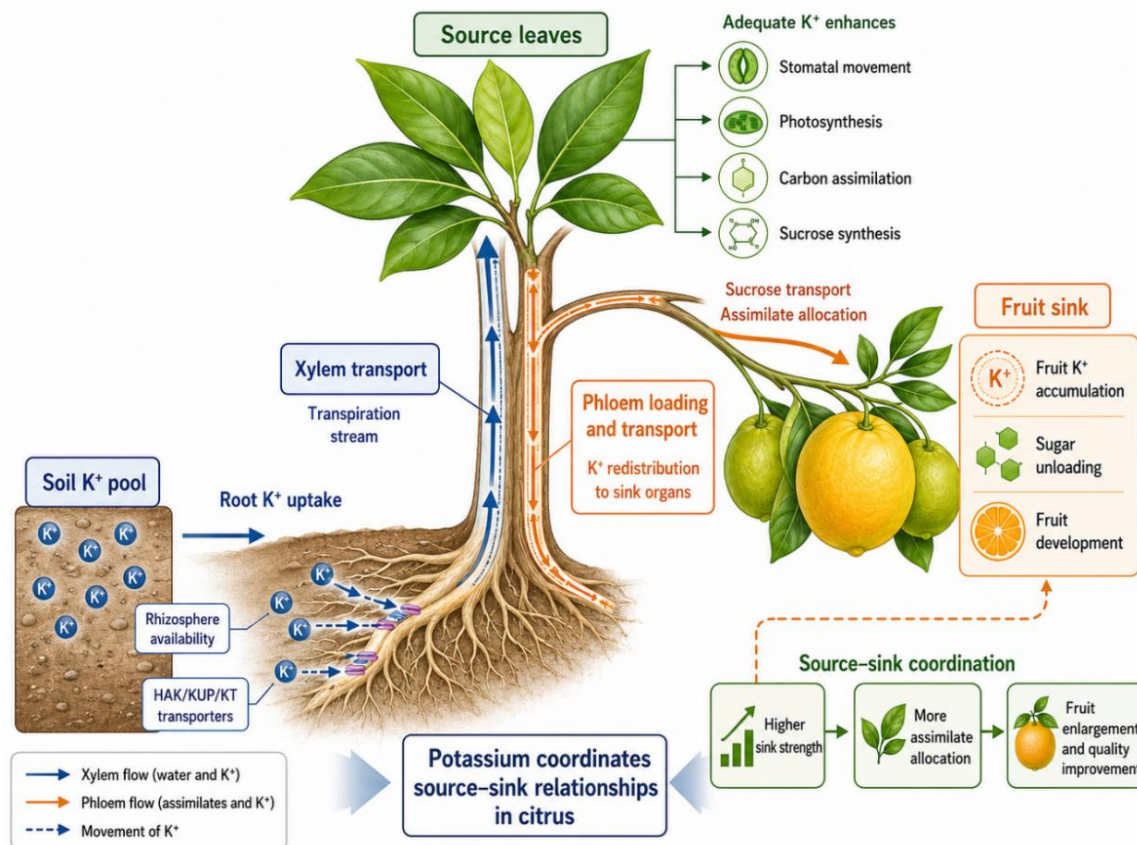


Figure 1 Potassium uptake, transport, and source-sink regulation in citrus plants

Image caption: The figure illustrates potassium uptake, transport, and source-sink regulation in citrus plants. Soil-derived K^+ is absorbed by roots through HAK/KUP/KT transporters and transported upward via the xylem. In source leaves, potassium enhances stomatal regulation, photosynthesis, carbon assimilation, and sucrose synthesis. Subsequently, K^+ facilitates phloem loading and assimilate transport toward fruit sink tissues, promoting potassium accumulation, sugar unloading, fruit enlargement, and quality improvement

2.2 Potassium regulation of photosynthesis and carbon metabolism

Potassium directly regulates stomatal function and plant water relations, and sufficient potassium supply generally improves CO_2 assimilation capacity and photosynthetic efficiency in citrus and other plant species (Wen et al., 2021; Johnson et al., 2022). Studies have shown that potassium fertilization increases the net photosynthetic rate, stomatal conductance, and intercellular CO_2 concentration in citrus cultivars prone to fruit cracking, indicating that an adequate potassium level can improve leaf gas exchange processes (Jiao et al., 2022).

Broader studies across plant species have also demonstrated that potassium deficiency reduces photosynthetic carbon assimilation capacity, leading to impaired photosynthesis and decreased assimilate utilization efficiency (Anil Kumar et al., 2024). Physiologically, these effects are closely associated with the involvement of potassium in regulating membrane potential, intracellular pH stability, osmotic balance, and enzyme systems related to photosynthesis and respiration (Raddatz et al., 2020; Jiao et al., 2022).

Potassium promotes carbohydrate synthesis in source leaves and enhances the transport of photosynthetic products to fruits, thereby facilitating carbon metabolism in citrus plants (Wen et al., 2021). In Newhall navel orange, potassium application enhanced leaf photosynthesis, increased the activity of sucrose phosphate synthase (SPS) and the expression of the *CsSPS* gene, while also improving the activities of SPS and sucrose synthase (SS)