in fruits, indicating that potassium simultaneously promotes metabolic processes in both source and sink tissues (Wu et al., 2024).

Further studies by Wu et al. (2024) demonstrated that potassium supply increased the accumulation of ^{13}C-sucrose and ^{13}C-glucose in fruits, suggesting that potassium enhances carbon transport from leaves to fruits during fruit enlargement and coloration stages. This transport effect has a clear physiological basis, as potassium is one of the major osmotic regulators in phloem sap and contributes to maintaining phloem pressure flow, thereby facilitating the transport of sucrose and other solutes (Tränkner et al., 2018).

2.3 Potassium and fruit development processes

Potassium promotes citrus fruit enlargement, partly because it regulates cellular osmotic potential and turgor pressure, both of which are fundamental processes underlying cell expansion (Wen et al., 2021; Wu et al., 2024). Jiao et al. (2022) demonstrated that potassium is associated with fruit cell division, root proliferation, and enhancement of peel tissues, suggesting that potassium not only affects fruit cell expansion but also contributes to maintaining the vegetative growth system that supports fruit development. At the whole-fruit developmental level, an adequate potassium supply can increase fruit growth rate in Newhall orange, while repeated foliar applications of K_2SO_4 during citrus development can also increase individual fruit weight (Wu et al., 2024). Related orchard studies further indicate that potassium promotes fruit enlargement, improves peel coloration, and alters peel thickness; however, these effects are influenced by potassium application rate, fertilizer type, and cultivation management practices (Wen et al., 2021).

Thu et al. (2024) reported that potassium enhances citrus fruit sink strength by coordinating sugar metabolism, transporter activity, and vascular transport of assimilates. In Newhall navel orange, maintaining fruit potassium concentration at an optimal level of approximately 1.5% improved fruit quality and promoted sugar accumulation (Wu et al., 2024). During citrus fruit development, foliar application of K_2SO_4 also increased soluble sugar content, total soluble solids (TSS), and the TSS:TA ratio, while upregulating the expression of genes associated with sugar metabolism and transport, including *CsCWINV-2/6*, *CsSUT-1/2*, and *CsVPP-1/2*. These findings further support the model that potassium promotes fruit quality formation by enhancing sink strength (Thu et al., 2024).

3 Effects of Potassium Fertilization on Citrus Fruit Size

3.1 Potassium effects on fruit growth and expansion

Previous studies have shown that potassium promotes fruit growth by enhancing cell division and cell elongation, while maintaining the turgor pressure required for cell expansion during fruit development (Toor et al., 2021; Jiao et al., 2022). In citrus, potassium promotes root proliferation and improves nutrient uptake capacity, thereby indirectly supporting rapid fruit growth during the cell division and enlargement stages (Jiao et al., 2022).

The timing of potassium supply is also critical, as citrus fruits exhibit different sensitivities to potassium availability throughout their developmental stages. Thu et al. (2024) found in Nanfeng mandarin that continuous foliar application of K_2SO_4 during the cell division, cell enlargement, and maturation stages produced greater growth-promoting effects than potassium application restricted to a single developmental stage. Studies on pomelo have also identified distinct periods of high potassium demand. Approximately two months after fruit set represents a critical developmental stage, indicating that potassium supply needs to coincide with peak fruit nutrient requirements to achieve optimal effects (Magbalot-Fernandez and Guzman, 2019).

Potassium fertilization generally increases fruit weight directly. In Kinnow mandarin, soil potassium application significantly increased individual fruit weight, fruit number, and overall yield (Singh et al., 2023). In Baladi lemon cultivated under potassium-deficient soil conditions, foliar potassium application improved fruit size-related traits. Among different treatments, potassium tartrate resulted in the highest individual fruit weight and volume in 2022, while high-concentration potassium citrate increased fruit weight, volume, and dry matter content across multiple seasons (Awad et al., 2024).