Magbalot-Fernandez and Guzman (2019) reported that increasing potassium application to 225 g per tree in 'Magallanes' pomelo increased individual fruit weight by 22%-26%, although fruit diameter and length did not show significant changes. This indicates that potassium can enhance fruit biomass accumulation but may not necessarily alter linear fruit size parameters. Studies on Newhall orange further confirmed the role of potassium in promoting fruit growth, showing that an adequate potassium level increased fruit growth rate and overall quality, with the optimal response occurring when fruit potassium concentration was maintained at approximately 1.5% (Wu et al., 2024).

3.2 Potassium regulation of source-sink relationships

One of the important pathways through which potassium promotes fruit enlargement is by improving leaf photosynthetic capacity and enhancing the supply capacity of source tissues. Studies have shown that potassium regulates stomatal movement, plant water relations, and photosynthetic processes (Hasanuzzaman et al., 2018; Johnson et al., 2022). For example, potassium deficiency in hydroponically grown lemon plants resulted in reductions in photosynthetic rate, stomatal conductance, transpiration rate, intercellular CO_2 concentration, and pigment content, although different rootstock materials exhibited certain variations in their responses (Papadakis et al., 2023). In contrast, potassium application in citrus cultivars susceptible to fruit cracking increased photosynthetic rate, stomatal conductance, and intercellular CO_2 concentration, indicating that adequate potassium supply improves leaf gas exchange capacity (Jiao et al., 2022). Foliar potassium application in lemon also increased SPAD values, photosynthetic performance index, and leaf nutritional status, which is consistent with the enhanced activity of source tissues under sufficient potassium availability (Awad et al., 2024).

Potassium can also promote fruit enlargement by enhancing carbohydrate transport from leaves to fruits. Wu et al. (2024) found in Newhall navel orange that potassium supply simultaneously enhanced both source strength and sink strength, increased fruit growth rate, and promoted sucrose transport from source leaves to fruits. Mechanistically, potassium enhances carbon transport through the symplastic loading pathway by increasing the number of plasmodesmata and the intensity of carboxyfluorescein signal transmission, indicating improved phloem loading capacity during fruit development.

Similar patterns have been observed in Cara Cara navel orange, where potassium increased sucrose, fructose, and glucose contents by regulating the activities of sucrose metabolism-related enzymes, thereby enhancing fruit sink strength (Wu et al., 2021). Studies on other non-citrus fruit trees have also demonstrated that potassium increases carbon import rates into sink organs and promotes the activity of enzymes involved in sugar conversion, which is consistent with the "source-sink regulation" model observed in citrus (Luo et al., 2021).

3.3 Factors influencing potassium responses in citrus

Citrus genotypes do not respond uniformly to potassium fertilization. A meta-analysis by Xu et al. (2024) demonstrated that different citrus groups, including mandarins, pomelos, and sweet oranges, showed distinct growth and yield responses after optimized fertilization. Specific experiments have further confirmed these differences. For example, potassium application in pomelo substantially increased fruit set, fruit number, and individual fruit weight, but had limited effects on fruit diameter and length (Magbalot-Fernandez and Guzman, 2019). In contrast, lemon plants showed strong selectivity toward potassium sources, with different potassium fertilizers (potassium citrate, potassium tartrate, and potassium nitrate) exhibiting advantages for different fruit quality parameters (Awad et al., 2024). Rootstock type also affects potassium utilization efficiency. Papadakis et al. (2023) reported that in lemon, the effects of potassium on plant growth, photosynthetic performance, and mineral nutrient distribution were regulated by rootstock genotype.

Environmental conditions also determine the effectiveness of potassium fertilization. Due to differences in soil properties and climatic conditions, citrus responses to potassium supply are not always consistent among orchard studies (Wen et al., 2021; Papadakis et al., 2023). Among environmental factors, water management is particularly important. In sweet orange production, fertigation with only 50% of the recommended nitrogen and potassium rates achieved the highest yield and increased nutrient use efficiency by 22%; however, applying 100%