number, individual fruit weight, and yield, indicating that the optimal potassium rate depends on specific production objectives.

Studies on lemon and Kinnow mandarin further demonstrate that fertilization methods and treatment combinations should be matched with production goals. Foliar application of NG-K was more effective than basal application of sulfate of potash (SOP) in improving sugar accumulation and juice quality parameters (Tahir et al., 2023). Among different management strategies, application of a salicylic acid (SA) + potassium (K) + zinc (Zn) combination across three growth stages showed the most consistent effects in reducing fruit drop and improving juice quality across multiple locations (Anwar et al., 2022).

8 Advances and Future Trends in Citrus Potassium Management

Potassium is an essential nutrient that influences citrus tree growth and fruit quality formation, playing important roles in photosynthetic carbon assimilation, assimilate transport, fruit development, and quality regulation during maturation. Current studies indicate that appropriate potassium supply can improve leaf photosynthetic capacity, enhance material transport between source and sink tissues, and promote fruit enlargement and sugar accumulation. The effectiveness of potassium management is affected by multiple factors, including cultivar characteristics, rootstock type, soil conditions, water availability, and fertilization practices. Developing potassium management strategies adapted to different production conditions is therefore an important basis for achieving high-quality and efficient citrus production.

The regulatory effects of potassium on citrus fruit development are mainly associated with improved cellular expansion conditions, enhanced fruit growth, and strengthened nutrient supply capacity of the tree. Potassium demand is generally higher during rapid fruit growth and maturation stages, and timely potassium supplementation can improve fruit weight and marketability. Different citrus groups show distinct responses to potassium supply, with some cultivars exhibiting stronger effects on fruit enlargement, whereas others respond more significantly in terms of sugar accumulation and flavor improvement. In practical production, fertilization strategies should be adjusted according to cultivar characteristics and developmental stages to improve the synchronization between potassium supply and tree nutrient requirements.

The role of potassium in fruit quality formation is closely related to carbon metabolism and sugar transport processes. An appropriate potassium level promotes the translocation of photosynthetic products to fruits, regulates the activities of sucrose metabolism-related enzymes, and affects sugar transport processes, ultimately improving total soluble solids content and sugar–acid balance. However, excessive potassium supply may interfere with the uptake of calcium, magnesium, and other mineral elements, resulting in nutrient imbalance and reduced fertilizer use efficiency. Therefore, maintaining a balanced relationship between potassium and other mineral nutrients is essential for producing high-quality citrus fruits, and excessive potassium input should be avoided.

Future research should further improve precision potassium management systems in citrus orchards. Potassium requirements under different cultivar–rootstock combinations and ecological regions need to be validated through long-term field experiments, combined with leaf nutrient diagnosis and soil nutrient monitoring to establish more reliable evaluation indicators. The molecular basis underlying potassium regulation of fruit quality formation also requires further investigation, particularly regarding the interactions between potassium signaling, sugar metabolism networks, hormonal regulation, and fruit ripening processes.

With the development of fertigation, remote sensing, and smart agriculture technologies, citrus potassium management is expected to become increasingly dynamic and precise. Integrating soil, plant, and environmental information for nutrient demand prediction can improve potassium use efficiency and reduce resource losses. Future studies should strengthen the coordination of potassium management with irrigation, nitrogen and phosphorus nutrition, and micronutrient regulation, aiming to establish a more efficient, stable, and sustainable