pruning strategies based on light environment monitoring can reduce pruning frequency by approximately 35%-42%, while maintaining yield and increasing soluble solids content (Kim and Kubota, 2025). Under winter conditions, leaf pruning and LED supplemental lighting exhibit clear synergistic effects, with supplemental lighting significantly increasing yield and accelerating fruit maturation.

Figure 6 Demonstration of cultivation management and growth status of greenhouse-grown tomatoes

7.2 Effects of integrated water and fertilizer management on nutrient supply and yield stability

Integrated water-fertilizer management is an important technique for efficient protected tomato cultivation. Its core principle is the precise coupling of irrigation and fertilization to achieve dynamic matching between water and nutrient supply in the root zone, thereby maintaining stable plant growth and improving resource-use efficiency. Compared with traditional fertilization methods, integrated water-fertilizer management emphasizes adjusting water and nutrient supply according to crop growth stages and environmental conditions in order to avoid growth imbalance caused by water stress or excessive nutrient supply. Tomatoes exhibit different water and nutrient requirements at different growth stages. During the seedling and vegetative growth stages, adequate water supply is needed to promote root development and leaf area expansion, whereas during flowering and fruiting stages, stable supplies of nitrogen, phosphorus, and potassium are required to maintain fruit set and fruit enlargement. Under drip irrigation in solar greenhouses, combining soluble organic fertilizers with chemical fertilizers and applying appropriate irrigation levels can significantly increase nitrogen uptake, yield, and water-use efficiency, while also providing more stable economic returns.

Clear synergistic effects exist between irrigation level and fertilization rate. Research indicates that under micro-seepage irrigation, a combination of moderate irrigation and moderate fertilization can achieve higher photosynthetic rates, greater dry matter accumulation, and higher yields, while also improving fertilizer-use efficiency (Liu et al., 2024). In substrate cultivation systems, initiating irrigation when substrate moisture declines to about 70% of its capacity significantly improves water-use efficiency and enhances fruit soluble solids and vitamin C content compared with irrigation at higher moisture levels. In addition, irrigation frequency and real-time monitoring also influence water and nutrient use efficiency. Shorter irrigation intervals under drip irrigation help maintain stable root-zone moisture conditions and promote root growth (Zhang et al., 2025a). Intelligent irrigation control using soil moisture sensors can further reduce irrigation water consumption while improving yield and nutrient uptake efficiency (Wang et al., 2024).

7.3 Application of growth regulators and pollination techniques to improve fruit set

Fruit set rate is an important limiting factor in yield formation of protected tomatoes, especially under suboptimal temperature, light, or humidity conditions. Therefore, the use of plant growth regulators, biostimulants, and assisted pollination technologies has become an important strategy for stabilizing yield in protected tomato production. Certain biostimulants can enhance plant vigor and increase yield by regulating endogenous hormone levels, promoting cell division, and stimulating chlorophyll formation. Applying biostimulants such as Albit and