If fruit enlargement rates differ greatly among fruits on the same truss or the same plant, uneven ripening is likely to occur, increasing the number of harvest rounds, raising the difficulty of manual grading, and reducing packaging standardization. In greenhouse tomato quality control systems, uniform fruit shape, smooth fruit surface, and fewer mechanical or physiological defects are usually important prerequisites for fruits to enter high-grade commercial circulation systems. Surface defects such as fruit cracking, scarring, zippering, and wind scars can significantly reduce commercial value, and fruits may be downgraded even if their weight meets the standard. Therefore, the marketability of protected tomatoes is not determined solely by large fruit, but is instead the combined result of fruit shape stability + size uniformity + skin integrity.

From the perspective of genetic basis, fruit shape, fruit size, and susceptibility to commercial defects are interrelated. GLOBE locus on chromosome 12 can significantly affect the difference between oblate and spherical fruit shapes in large-fruited fresh-market tomatoes, while also influencing fruit size, pedicel morphology, and the tendency for skin defects to occur (Sierra-Orozco et al., 2021). Among these, spherical-fruit materials often have larger fruits, but are also more prone to surface cracking and epidermal defects, thereby creating a trade-off among fruit shape, fruit weight, and marketability (Sierra-Orozco et al., 2021). This indicates that in protected tomato breeding and cultivation, simply pursuing larger fruit does not necessarily lead to higher market returns; fruit shape stability and defect control must also be considered simultaneously. With the development of phenotypic analysis and digital agriculture technologies, evaluation of fruit shape and uniformity is gradually shifting from experience-based judgment to standardization and intelligence. Machine-learning classification systems established using standardized fruit-shape parameters from tools such as Tomato Analyzer have already shown greater stability and consistency than manual evaluation in tomato fruit-shape classification, and can be used for breeding material screening, fruit grading, and supply-chain quality control (Vazquez et al., 2024). In addition, some preharvest growth-regulation measures can improve fruit shape and internal quality to a certain extent. For example, benzylaminopurine (BAP) and gibberellin treatments can alter the fruit shape index of small-fruited greenhouse tomatoes, making fruits shift from elongated forms to more rounded ones, accompanied by changes in soluble solids and some nutritional indicators. This suggests that fruit shape is plastic to a certain extent and can be optimized through physiological regulation (Eissa et al., 2025).

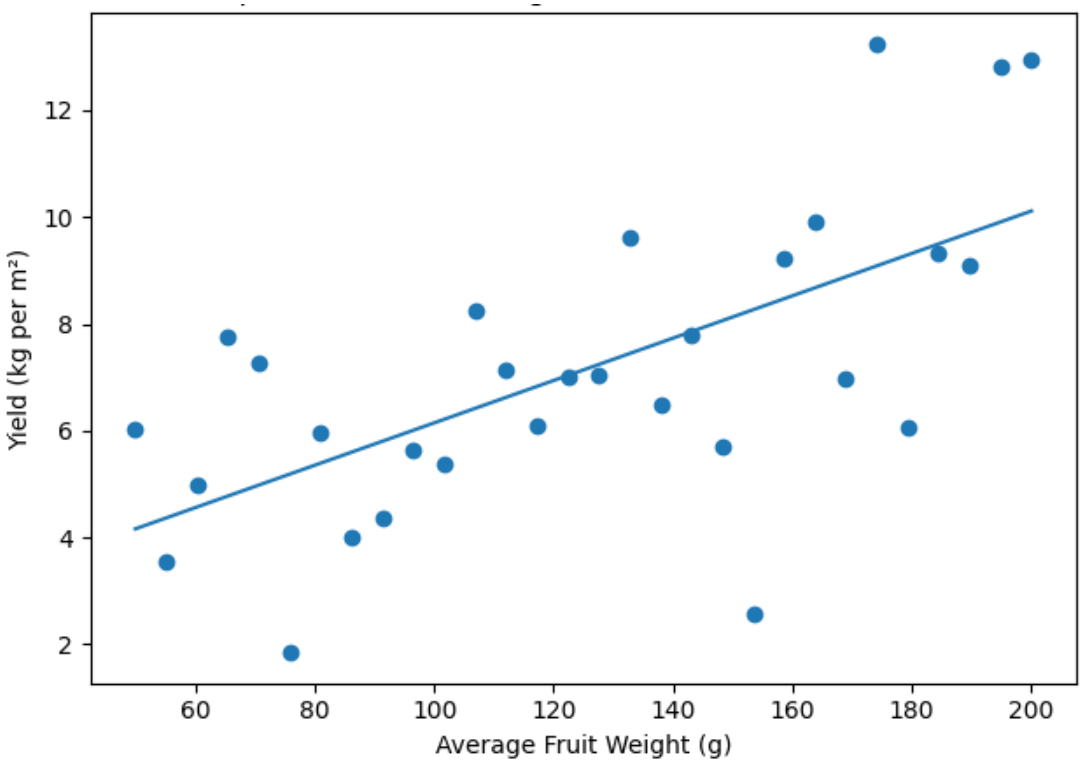

Figure 3 Relationship between average fruit weight and total yield of greenhouse-grown tomatoes under different irrigation treatments