2020). In experimental eggplant systems, grafted plants often show increased stem diameter, higher chlorophyll values, and higher yield than self-rooted plants, indicating that the physiological response is expressed in both vegetative growth and reproductive performance (Du et al., 2024). These physiological changes are coordinated by long-distance signaling between the graft partners. Evidence across grafted vegetables shows that hormones, minerals, mRNAs, non-coding RNAs, and proteins move through the vascular system and contribute to the regulation of scion phenotype after grafting. Hormonal control is especially important at the union, where auxin, cytokinin, ethylene, gibberellin, and jasmonic acid help coordinate wound healing, vascular differentiation, and rootstock-scion communication (Habibi et al., 2022).

At the molecular level, grafting triggers substantial transcriptional reprogramming, and compatible versus incompatible unions can differ sharply in gene expression patterns. Heterografts tend to show stronger activation of oxidative stress and stress-response genes, whereas successful unions more effectively upregulate genes involved in cell-wall synthesis, wound responses, hormone signaling, and vascular regeneration. This helps explain why graft healing is not only an anatomical process but also a genetically regulated response shaped by recognition, metabolic balance, and signaling across the junction. Eggplant studies further suggest that some graft-induced responses involve epigenetic regulation. Heterografting-associated vigor in eggplant has been linked to genome-wide CHH hypomethylation and altered scion gene expression, supporting the idea that rootstocks can reshape scion phenotype partly through methylation-dependent regulation. More broadly, grafting can induce DNA methylation changes, small-RNA-mediated signaling, and transcriptional reprogramming across the union, making epigenetic control a plausible mechanism by which grafting influences growth, stress responses, and yield-related traits in eggplant.

## 3 Effects of Grafting on Eggplant Vegetative Growth

### 3.1 Influence on plant morphological development

Grafting generally enhances vegetative vigor in eggplant, especially when vigorous or wild rootstocks are used. Field evidence showed significant differences between grafted and non-grafted plants in plant height, total leaf area, stem diameter, and chlorophyll index, with the Pala/Köksal F1 combination reaching about 1.0 m in height, 5645.04 $cm^2$/plant leaf area, and a SPAD value of 47.48 (Ulaş, 2021). Greenhouse results similarly found that grafted plants had thicker stems and higher chlorophyll content than self-rooted controls, indicating that grafting promotes stronger shoot development early in crop establishment (Du et al., 2024). The magnitude of morphological improvement depends on the rootstock-scion combination. Grafting onto *Solanum torvum* or *S. aethiopicum* increased plant height at 50 days after transplanting by 11.6% and 9%, respectively, relative to non-grafted plants, while combinations involving wild relatives in open-field trials also showed superior overall growth performance across years (Consentino et al., 2022). Not all vigorous combinations are equally desirable, however, because some highly stimulating rootstocks can induce excessive vegetative growth and disorder, as seen in the Beaufort/Black Bell combination, where vegetative traits were highest but compatibility was weaker and growth became imbalanced (Argento et al., 2023).

### 3.2 Effects on root system development and nutrient uptake

One of the clearest effects of grafting on vegetative growth is the strengthening of the root system. In grafted eggplant, rootstocks significantly increased shoot and root fresh and dry biomass, with Topan/Köksal F1 reaching 66.29 g/plant root fresh weight and 11.05 g/plant root dry weight, well above the non-grafted control (Ulaş, 2021). Similar evidence from low-cost polyhouse production showed that all grafted plants had superior rooting, and the greatest root number, root length, root fresh weight, and root dry weight were recorded with *S. torvum*, followed by *S. khasianum*.

These root improvements translate into stronger nutrient acquisition and greater tolerance to low-input or stressful conditions. In a soilless system, plants grafted onto *S. torvum* had greater plant dry weight and yield than self-grafted controls, and this vigor was directly linked to major root development and higher accumulation of most analyzed mineral ions. More recent work under deficit irrigation likewise found that grafted plants developed greater root proliferation and improved water and nutrient uptake, which helped reduce yield losses under water stress and supported more stable vegetative performance (Wakchaure et al., 2025).