Long-term yield stability under organic nutrient management appears achievable, but it depends on balanced formulations and local conditions rather than on organic inputs alone. Reviews of tropical and sustainable viticulture converge that nutrient-specific, integrated fertilization is the most reliable route to sustaining productivity and grape quality over time (Cataldo et al., 2021; James et al., 2023). Multi-year and long-term studies show that organic fertilization can stabilize soil carbon, microbial biomass, and nutrient cycling, which supports durable production capacity (Fracetto et al., 2024). However, field comparisons in Riesling found lower growth and yield under organic and biodynamic systems than under integrated management, and subtropical trials with grape pomace compost or vermicompost found negligible benefits in Chardonnay and reduced yield in Isabella (Döring et al., 2015; Kokkonen et al., 2025).

## 6 Effects of Organic Fertilization on Grape Fruit Quality

### 6.1 Regulation of sugar and organic acid accumulation

Organic fertilization often increases soluble solids and soluble sugars when nutrient supply is balanced rather than excessive. In Isabel Precoce grapes, organic fertilization with up to 90 kg/ha N increased soluble solids to about 17 °Brix, total soluble sugars, reducing sugars, and the soluble solids-to-acidity ratio (De Lima et al., 2021). In Superior grapevines, replacing part of mineral N with chicken manure and biofertilizer increased total soluble solids, reducing sugars, and berry quality progressively as mineral N was reduced from 100% to 40% (Muhammed et al., 2023). In Shine Muscat, reducing N by 20%-30% while adding organic fertilizer consistently increased total sugar and the sugar–acid ratio, and potassium availability emerged as the key factor regulating sugar accumulation and flavor coordination (Huang et al., 2026). Multi-year Royal grape studies likewise showed that tillage plus organic amendments significantly altered berry sugar composition, with treatment-dependent increases in sucrose, glucose, and fructose and the highest rhamnose, galactose, and xylose under broccoli fertilizer in some combinations (Kaya et al., 2024b).

Effects on titratable acidity and sugar–acid balance are generally favorable but less uniform than effects on sugar accumulation. Partial replacement of mineral N with organic and biofertilizers decreased total acidity in Superior berries while increasing the TSS/acid ratio (Muhammed et al., 2023). In Shine Muscat, Huang et al. (2026) found that the 0.8N + organic fertilizer treatment increased the sugar–acid ratio together with total sugar and vitamin C. Increased organic fertilization with reduced chemical fertilizer also lowered grape juice pH in arid vineyards, consistent with improved flavor balance (Wu et al., 2021). However, acidity responses are not consistent across cultivars: pH and titratable acidity were unaffected in white seedless grapes under organic, conventional, and integrated fertilization, and organic fertilization did not affect most quality traits of ‘Syrah’ must (Koureh et al., 2019; da Silva et al., 2024). This variability is biologically plausible because sugar and acid profiles are strongly stage-dependent, with sugars rising and organic acids shifting markedly from veraison to ripening (Yılmaz et al., 2024).

### 6.2 Effects on phenolic and aroma-related compounds

Organic fertilization often enhances anthocyanins, flavonoids, and total phenolics, especially when nutrient supply promotes moderate stress and balanced ripening. In white seedless grape, organic fertilization produced the highest total phenolics, catechin, and quercetin-3-galactoside, while antioxidant activity and total flavonoids were highest under organic or integrated systems (Koureh et al., 2019). In Royal grapes, three-year studies showed significant treatment effects on phenolics and anthocyanins, with broccoli-based fertilization generally producing the strongest increases and specific tillage-fertilizer combinations enhancing compounds such as resveratrol, pterostilbene, vanillic acid, and trans-caffeic acid (Kaya et al., 2024b). Organic and combined fertilization schedules in Cabernet Sauvignon also increased berry quality through higher total phenols or tannins and linked these changes to shifts in soil bacterial communities associated with anthocyanin and tannin accumulation (Wang et al., 2021). Soil-conditioner work supports the same direction, showing higher anthocyanins, tannins, and total phenols than standard NPK or organic fertilizer alone (Jiang et al., 2024). Phenolic responses are not universally positive: in Isabel Precoce, the highest polyphenol and anthocyanin contents occurred with mineral N up to 60 kg/ ha without organic fertilization (De Lima et al., 2021).