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Fertilization Lysimeters provide new insights into the needs and impacts of N nutrition on table grape performance and fruit yield and quality

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Abstract

Table grape production requires adequate nitrogen (N) supply to sustain vine performance and obtain high yields. However, excess agricultural N fertilization is a major source of groundwater contamination and air pollution. Therefore, there is a strong need for empirically based precision N fertilization schemes in vineyards, for optimizing grape yield and quality while minimizing their environmental impact.

Our aim was to unequivocally quantify table grape N requirements, elucidate the drivers of daily N uptake, and quantify the relationship between fertigation N levels and vine growth, fruit yield, composition, and quality. For this, forty 'Early Sweet' (early-maturing, white) and 'Crimson seedless' (late-maturing, red) vines were grown in 500L drainage-lysimeters for 2 fruiting seasons, while subjected to five continuous N fertigation treatments ranging from 10 to 200 ppm. Irrigation and drainage volume and macronutrient concentrations were measured bi-weekly. Vegetative growth, leaf mineral composition, and fruit ripening were monitored, and the fruit harvested and analyzed for quality-related parameters.

Vine temporal N uptake across seasons and treatments was largely driven by N availability and water uptake, independently of fruit phenology. N levels affected the composition of other macro and micro-nutrients in diagnostic tissues. A dose-dependent effect of N on plant growth, fruit ripening, yield, and fruit size and composition highlighted doses that improve both yield and quality, and nitrogen use efficiency. Our findings lay the basis for data-driven precision N nutrition in vineyards for optimizing yield, fruit quality, and the environmental sustainability of commercial vineyards.

Keywords: Nitrogen use efficiency, Fertigation, Precision fertilization, Grape quality, Sustainable agriculture.