Integrated Application of K and Zn as an Avenue to Promote Sugar Beet Yield, Industrial Sugar Quality, and K-Use Efficiency in a Salty Semi-Arid Agro-Ecosystem

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Abstract

Salinity combined with a deficiency of potassium (K) and zinc (Zn) negatively affect sugar beet yield and quality. A two-year (2017/18–2018/19) field trial was undertaken to investigate the mediating role of soil-applied K [120 (K_{120}) and 180 (K_{180}) kg ha^{-1}] and foliar-applied Zn [0 (Zn_0), 150 (Zn_{150}), and 300 (Zn_{300}) ppm] in alleviating salt-stress (8.60 dS m^{-1}) based on sugar beet morpho-physiological responses, sugar yield and quality, and K-use efficiency in the BTS 301 and Kawemira cultivars. Application of K_{180} x Zn_{300} was more effective and resulted in 23.39 and 37.78% higher root yield (RY) and pure sugar yield (PSY), respectively, compared to control (K_{120} x Zn_0). It also enhanced sucrose, pure sugar (PS), and purity but decreased impurities (α-amino N, K, and Na), alkalinity index, and sugar loss. However, the K_{120} x Zn_{300} recorded higher K-use efficiency. PSY correlated positively ($r = 0.776^{**}$, 0.629^{**}, 0.602^{**}, 0.549^{**}, and 0.513^{**}) with RY, root fresh weight (RFW), top yield, PS, and root diameter, respectively. The stepwise and path-coefficient analysis demonstrated that RY, PS, and RFW were the most influential PSY-affected attributes. Integration of K_{180} + Zn_{300} can correct K and Zn deficiencies in the soil and mitigate salt-stress effects via improving sugar beet growth, yield and quality, and K-use efficiency.