Onion (Allium cepa) is a vital crop serving both as a dietary staple and a source of income for farmers, with significant market benefits. However, its potential as a functional food is limited by poor growth, low yields, and reduced bioactive compounds, which diminish marketability. Therefore, this research aimed to investigate the effects of sulfur (S), calcium (Ca), and magnesium (Mg) supplementation on onion growth, yield, and bioactive compounds. A Randomized Complete Block Design (RCBD) was adopted across major onion production areas in Kenya: Kisaju-Kajiado and Koma-Machakos. Experimental treatments included varying levels and combinations of S, Ca, and Mg supplementation. Preliminary tests including Levene's, Kolmogorov-Smirnov, Durbin-Watson, Shapiro-Wilk, Cox and Snell, Nagelkerke, and McFadden tests were performed to assess normality, linear and multinomial regression, and collinearity using SPSS software. Analysis of Variance (ANOVA) was performed, and where significant differences were found, Post Hoc tests were conducted. Significant differences were observed, leading to rejection of the null hypothesis. The treatment with S, Ca, and Mg at 40 kg/ha significantly produced the best performing onions as well as market returns on the 'Red Creole' onion variety. Kisaju-Kajiado was also found to be the optimal location for onion production, with high return-on-investment profits. This research is recommended for farmers intending to improve onion performance and marketability. The study concludes that S, Ca, and Mg supplements significantly improve onion growth, yield, and bioactive compounds, thereby increasing marketability.