Across the available comparisons, the magnitude of Si responses differed substantially among trait categories. Growth and photosynthetic traits generally showed moderate improvements, whereas oxidative damage and Na^+ accumulation exhibited larger and more consistent reductions (Figure 2).

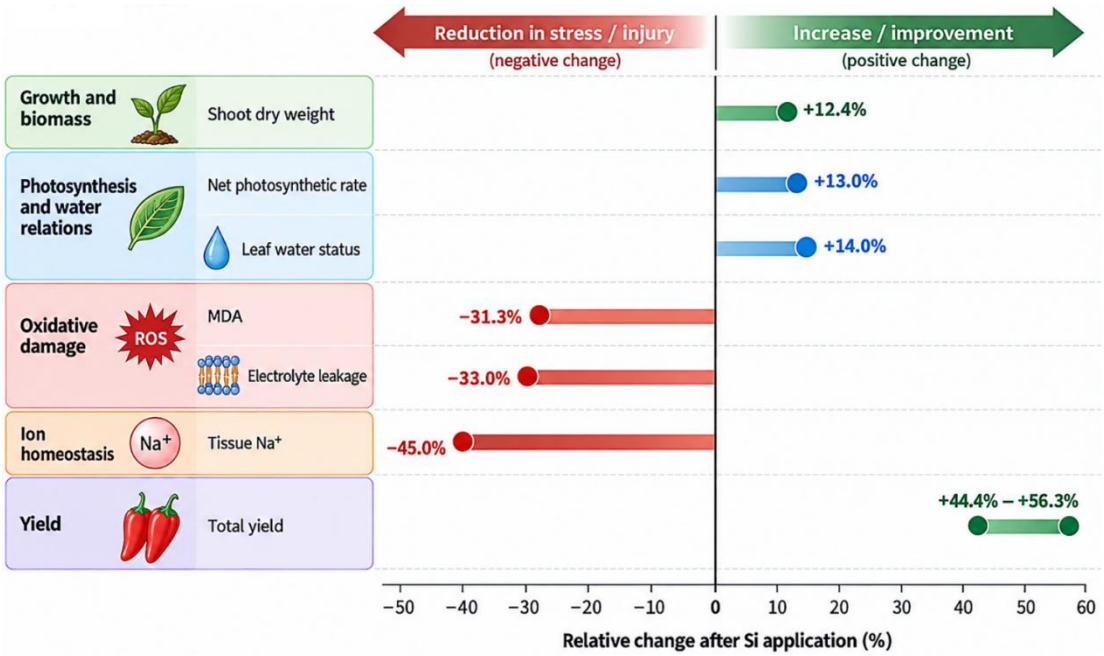


Figure 2 Exploratory summary of major responses of salt-stressed pepper to silicon application.

Image caption: Representative relative responses extracted from directly comparable Si-salinity treatments in pepper. Positive values indicate increases following Si application, whereas negative values indicate reductions in stress- or damage-related traits. Values for shoot dry weight, net photosynthetic rate, leaf water status, MDA, electrolyte leakage, and Na^+ represent exploratory median or representative responses derived from available comparisons. Yield responses should be interpreted cautiously because the available estimates are based on a limited number of experimental systems. These values are not variance-weighted pooled effect sizes

7 Factors Determining the Effectiveness of Exogenous Silicon in Pepper under Salinity Stress

7.1 Silicon source and application characteristics

Existing studies in pepper have used K_2SiO_3, foliar Si formulations, and SiO_2 nanoparticles. These treatments are not directly interchangeable. Potassium silicate supplies K simultaneously with Si, whereas nanosilicon has a larger specific surface area and differs in its uptake behavior and interfacial reactivity. In the 'Mızrak' experiment, 0.5-1 mM nanosilicon generally produced better responses, while increasing the concentration further to 2-3 mM did not result in a continued increase in effectiveness (Kusvuran et al., 2024). Similarly, marked differences were observed between 200 and 1 000 mg/L SiO_2 nanoparticle treatments in sweet pepper. A higher dose therefore cannot be assumed to be more effective (González-García et al., 2021).

Application through the nutrient solution is commonly used experimentally because it can directly influence root function and ion uptake. Foliar application, by contrast, is more relevant to some production systems and may also reduce the risk of Si immobilization in soil. Abdelaal et al. (2020) observed improvements in plant water status, oxidative damage, and yield following foliar Si application. Nanosilicon studies have likewise used both foliar and root-zone application. However, there are still too few studies in pepper directly comparing different application sites using the same Si source and dose. It is therefore not yet possible to determine which application method is consistently superior.

Based on the available evidence, soluble Si treatments in pepper are commonly applied at concentrations around 1.8-2 mM, whereas the effective concentration range of nanosilicon cannot be directly converted to that of conventional Si salts. Kusvuran et al. (2024) applied nanosilicon every 7 d and found that 1 mM generally performed well. In contrast, Badem and Söylemez (2022) used 2 mM Si while also evaluating the frequency of