However, the benefits were not uniform across all growth metrics. While plant height showed clear gains, other parameters like leaf number and stem girth exhibited only limited or no significant enhancement from H_2O_2 treatment. This pattern points to species-specific sensitivities in maize or concentration dependent responses of H_2O_2, where the applied dose or timing may optimally influence certain traits but not others. Comparable variability has been documented in different crops exposed to salinity or related stresses, highlighting that H_2O_2 efficacy can vary based on plant type, stress severity, and application details (Roque et al., 2024; Thomas et al., 2025).

Table 6 Leaf chlorophyll contents of *Zea mays* under salinity treatments with and without hydrogen peroxide (H_2O_2) application

Salinity treatment (mM NaCl)	With or without HP	Chlorophyll (mg/L)		Total chlorophyll (mg/L)
		A	b	
0	WHP	22.25	48.00	70.24
50		10.16	22.04	32.20
100		10.14	22.53	32.67
150		10.77	25.42	36.18
200		11.08	26.76	37.85
250		10.07	22.16	32.23
0	PHP	24.62	47.81	72.43
50		21.83	25.69	47.54
100		18.33	24.91	43.24
150		13.13	27.00	40.13
200		12.35	18.64	30.98
250		15.11	19.58	34.69

Note: PHP: plus hydrogen peroxide (H_2O_2); WHP: without hydrogen peroxide (H_2O_2)

Positive effects extended to vegetative biomass and root development, where H_2O_2 application led to noticeable improvements. These outcomes likely stem from better nutrient uptake and water retention capabilities under saline conditions, as salt stress typically disrupts ion balance and water availability, impairing root function and overall growth. Similar enhancements in biomass and root systems have been reported in other species like Mungbean and Tomato when H_2O_2 mitigates salt stress (Nehela et al., 2021). At moderate salinity levels (50~150 mM NaCl), H_2O_2 treated maize plants displayed approximately 10%~15% higher biomass than untreated counterparts. This advantage is attributable to strengthened antioxidant defenses which neutralize excess ROS and improved osmotic regulation, allowing plants to maintain physiological balance more effectively. These mechanisms tie directly into H_2O_2 broader role in orchestrating physiological adjustments during abiotic challenges (Ranjan et al., 2023; Saidi et al., 2024).

In terms of yield components, H_2O_2 positively affected key reproductive traits, most notably grain number per plant. Under severe stress at 250 mM NaCl, treated plants retained 88.12 grains per plant, compared to 84.50 in untreated plants. This indicates that H_2O_2 helps sustain reproductive development by minimizing oxidative damage to floral tissues and improving the allocation of assimilates (photosynthates) toward grain formation. Such protective influences on yield have been noted in maize and related crops under salinity (Rehan et al., 2025; Zhao et al., 2025). Nevertheless, the mitigation was only partial at higher salinity levels (200~250 mM NaCl), suggesting that HP protective effects have boundaries under extreme conditions. Severe stress can generate overwhelming ROS levels or cause profound ion toxicity (e.g., excessive Na^+ accumulation), which may exceed H_2O_2 capacity to fully counteract (Sachdev et al., 2021).

Beyond growth and yield, H_2O_2 helped preserve grain quality attributes. Proximate composition, such as protein content, remained more stable in treated plants (14.31% with H_2O_2 versus 13.44% without at 250 mM NaCl). Nutritional elements, including better potassium retention, were also maintained. These outcomes reflect H_2O_2 influence on metabolic stability, enabling continued synthesis of essential compounds and better ion homeostasis despite saline disruption. Related observations in other studies emphasize H_2O_2 contribution to nutrient metabolism and balanced ion regulation under stress (Saritha et al., 2020; Yadesa and Diro, 2023).