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Molasses-Induced Alleviation of Salinity Stress in Wheat Seedlings via Antioxidant Defense and Membrane Protection

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ABSTRACT

Salinity severely constrains wheat production in both coastal and arid irrigated areas, with early growth stages, especially seedling establishment, being extremely sensitive to salt stress. Excessive generation of ROS and followed by deterioration of cellular membranes are major factors contributing to salt-induced injury. To counter these adverse effects, beet molasses was used as a soil treatment at a dose of 0.5 ml/pot in the first irrigation, either alone or in combination with two levels of salinity (4000 and 6000 mg L^{-1}), using a completely randomized block design. The findings revealed that salinity levels significantly enhanced the production of H_2O_2 and $O2^{\bullet-}$ and malondialdehyde (MDA) content and reduced the membrane stability index (MSI) significantly. On the other hand, molasses treatment resulted in a significant decline of H_2O_2, $O2^{\bullet-}$, and MDA contents under salinity stress conditions. In parallel with this, molasses treatment also stimulated activities of antioxidant enzymes (AE), notably SOD, CAT, POD, APX, PPO, and total phenolic content across both salinity conditions. These results confirm the potential of beet molasses in managing salinity stress in wheat seedlings by decreasing oxidative injury in the plant membrane. highlighting its potential as an environmentally friendly and sustainable strategy for salinity stress management.

Keywords: antioxidant enzymes activity, malondialdehyde, membrane stability, reactive oxygen species, total phenols content, *Triticum aestivum*.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is considered one of the most strategically significant cereal crops grown in Egypt. Reports from FAO indicate that global wheat production reached approximately 736 million metric tons (FAO, 2015). Wheat yield has been decreasing continuously due to the ongoing process of climate change (Abdellaoui et al., 2023). At the moment, soil salinization is observed affect nearly one-fifth of global cultivated farmland; this figure is anticipated to rise due to climate change impacts and human-induced activities (Arora, 2019). Rising temperatures enhance soil water evaporation, which in turn promotes salt accumulation within the soil profile, leading to soil salinization (Khamidov et al., 2022). Increased salinity of the irrigation water and the soil have caused a decline in wheat yields (Yuan et al., 2024).

Salinity stress markedly enhances generation of ROS, particularly superoxide anions ($O_2^{\bullet-}$), and hydrogen peroxide (H_2O_2), thereby intensifying oxidative stress (OS) in plant tissues. Superoxide radicals, $O_2^{\bullet-}$, are primarily synthesized in chloroplasts, mitochondria, and peroxisomes owing to the disruption of electron transport chain under salt stress (SSS) conditions. Hydrogen peroxide, formed by the process of dismutation of superoxide radicals, is more stable and can cross cellular membranes, thus having the potential to act as a signaling molecule as well as an oxidizing agent

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causing damage (Hossain and Dietz, 2016; El-Beltagi et al., 2022). The over-accumulated ROS leads to lipid peroxidation, and this is often quantified by estimating malondialdehyde (MDA) accumulation. The damage caused by lipid peroxidation affects membrane fluidity, leading to increased ion leakage (Liu et al., 2024). In reaction to SSS conditions, plants counteract stress by upregulating key AE, namely SOD, CAT, APX, POD, and PPO, but not to a level that would completely counteract the high levels of ROS produced. Consequently, there will be oxidative damage, and plants will be affected through lipid peroxidation, leakage, and reduced growth (Rao et al., 2025).

Traditionally, soil salinity is controlled by the application of intensive irrigation measures aimed at leaching out the excess salt from the soil's root zone. However, this approach is becoming less sustainable in areas where water scarcity is a problem (Gupta and Goyal, 2017). During SSS conditions, a variety of physio-biochemical responses are triggered, and agronomic measures are often implemented to promote plant stress tolerance. Of all these approaches, organic amendments like molasses have attracted increasing attention due to their potential to provide osmo-protectants and antioxidants for seedling development under salinity stress conditions. The role of osmo-protectants like sugars in molasses is critical for osmotic adjustment and maintaining water balance within cells under SSS. Additionally, osmo-protectants activate key AElike SOD, CAT, POD, which reduce the production of ROS. Similar protective activities have been demonstrated when compatible solutes such as trehalose and mannitol were externally applied in wheat, which resulted in improved growth performance and protection against OS under salinity conditions (Alhudhaibi et al., 2024). In addition, the use of molasses provides wheat plants with amino acids that function as osmo-protectants and antioxidants, which help neutralize ROS, the augmentation of antioxidant defense system, and improvement of membrane stability, resulting in increased wheat seedling vigor during SSS conditions (Khedr et al., 2022). Organic components also have been found to upregulate the expression of PAL (phenylalanine ammonia-lyase), an essential enzyme participating in the induction of phenylpropanoid metabolism, leading to an enhanced of phenolic compounds deposition particularly flavonoids, lignin, and phenolic acids, which improve plant defense mechanisms and antioxidant activity (Ninkuu et al., 2025). In addition, organic carbon components also increase soil microbial activity, which, in turn, enhances nutrient absorption efficiency and strengthens plant tolerance to salinity stress (Dang et al., 2024). Although there are no direct studies on molasses use, its high sugar content clearly indicates a strong potential to minimize salinity-induced damage.

Following previous research, it was suggested that the beet molasses application could alleviate the impacts of salinity stress by promoting antioxidant enzyme function and maintaining the integrity of cellular membranes. Thus, this study was conducted with the aim of counteracting the damaging effects of SSS on wheat plants by boosting antioxidant defense and membrane protection. It has also been suggested that molasses application could provide a sustainable and environmentally safe strategy for alleviating salinity stress.

MATERIAL AND METHODS

The study was performed in an open-field setting at the Department of Agricultural Botany, Faculty of Agriculture, Kafrelsheikh University, Kafr El-Sheikh, Egypt, during 2025/2026 growing season. The experiment aimed at assessing the impact of soil application of molasses at a rate of 0.5 mL/pot under two salinity stress levels of 4000 and 6000 mg L^{-1}. Molasses composition used in this experiment was provided by Delta Sugar Company (DSC), El Hamoul, Kafr El-Sheikh, Egypt. Molasses' chemical composition is listed in Table 1. The amino acids present in beet molasses are given in Khedr et al. (2022).

Table 1. Chemical and physical analysis of beet molasses by Delta Sugar Company, El Hamoul, Kafr El-Sheikh, Egypt

Specific gravity	Dynamic viscosity	Apparent sucrose %	Purity	pH	True sucrose %	Reducing sugar %
1.415	1309.2	48.8	60.0	8.1	47.23	0.55
Raffinose %	Total sugar %	Nonfermentable sugar %	Fermentable sugar %	Total N %	Crude protein %	NO_2 ppm
103	52.34	2.37	49.97	1.7	10.63	39.7
NO_3 (ppm)	Organic acid as acetic acid %	Sulfated ash %	K %	Na %	CaO %	MgO %
194.2	0.5	9.9	4.1	1.8	0.2	0.08
S %	SO_2 %	SO_4 %	P %	Fe ppm	Zn ppm	Mn ppm
1.74	3.48	5.22	0.12	19.1	26.7	15.1
Cu ppm	Pb ppm	Ni ppm	Colloidal and suspended materials (g/g)			
2.25	0.95	2.2	0.39			

The experiment was conducted for the study of wheat germination behavior, growth characteristics, water relations in plants, and some chemical and biochemical properties. Clay soil was employed as a medium for the growth of plants. Soil physicochemical properties were determined by employing various analytical methods as outlined in Dane and Topp (2020), and Sparks et al. (2020) as summarized in Table 2.

Table 2. Physicochemical properties of the experimental soil

Mechanical analysis			Textural class	EC $dS.m^{-1}$ Soil. past	PH 1:2.5	% g/100 g			Available nutrients mg/L			
Sand %	Silt %	Clay %				$CaCo_3$	OM	S.P	N	P	K	Zn
18.21	30.30	51.49	Clayey	3.28	7.89	25.22	13.45	72	28.83	5.75	248	2.24
Cation meq/L					Anion meq/L							
Ca^{++}	Mg^{++}	Na^{+}	K^{+}		Co_3^{-}	HCo_3^{-}			Cl^{-}		So_4^{--}	
6.55	3.68	22.24	0.41		_	2.38			15.55		14.95	

Experimental design

The experiment included five treatments arranged in four replicates each. A complete randomized block design was utilized with polyethylene pots of 30 cm diameter and 40 cm depth. Each pot was equipped with 3 drainage holes at the bottom covered with sponges for water drainage, and 8 kg of soil was used for filling each pot. Wheat grains of *T. aestivum* L. cv. Masr 6 provided by the Cereal Crops Department, Field Crops Institute, Agricultural Research Center, Giza, Egypt, were used for this experiment. Sowing of seeds was carried out on 07th November 2025. Seedlings were thinned one month after sowing to maintain ten uniform plants in each pot. Chemical fertilization was used according to the Ministry of Agriculture and Soil Reclamation (MASR), Egypt, recommendations. Phosphorus and potassium fertilizers, as calcium phosphate (15.5% P_2O_5) and potassium sulfate (48% K_2O), respectively, at a rate of 1.8 and 0.6 g pot^{-1}, and the nitrogen fertilizer ammonium sulfate (20.5% N) at a rate of 1.8 g pot^{-1}, were applied before sowing. Diluted seawater was used for irrigation at equal volumes and according to plant requirements, depending on the level of salinity, while fresh water was used for the control plants.

Sampling, measurements and determination

For each treatment, a single sample was randomly collected exactly 45 days after

sowing during the experimental period. The subsequent characteristics were examined.

Hydrogen peroxide and superoxide anion

Hydrogen peroxide levels in leaves were measured according to Sergiev et al. (1997). Leaf samples (0.5 g) were homogenized in 1% (w/v) trichloroacetic acid (TCA), and mixture was centrifuged at 12,000 g for 20 minutes. Resulting solution was integrated with 0.7 cm^3 of 10 mM phosphate buffer (pH 7.0) and 1.4 cm^3 of 1 M potassium iodide (KI), and the solution was quantified for absorption at 390 nm. The concentration of H_2O_2 in the solution was determined from a standard calibration curve.

Superoxide anion ($O_2^{\bullet-}$) concentration was measured using procedure outlined by Achary et al. (2012). Leaf tissue (0.15 g) was incubated in 50 mM Tris-HCl buffer at pH 6.4 containing 0.2 mM nitroblue tetrazolium (NBT), 0.2 mM NADH, and 250 mM sucrose. Leaf tissue samples were vacuum infiltrated for 10-15 minutes and then kept under light at 200 μmol m^{-2} s^{-1} for 24 hours. Absorbance of the solution was measured at 530 nm, and concentration of superoxide was calculated utilizing extinction coefficient of 12.8 mM^{-1} cm^{-1}.

Preparation for Enzyme Extract

For antioxidant enzyme extraction, frozen wheat leaves were pulverized into fine powder using liquid nitrogen. The plant material was then homogenized in ice-cold 0.1 M Tris-HCl buffer (pH 7.5) containing 5% sucrose and 0.1% 2-mercaptoethanol at a 3:1 buffer-to-tissue ratio. The homogenate was then centrifuged at 10,000 × g for 20 minutes at 4°C, and the supernatant was utilized for enzyme activity assays. To maintain enzyme stability, all extractions and assays were conducted at 4°C.

Estimation of Enzymes Activity

Catalase (CAT, EC 1.11.1.6) activity was measured by observing the decline in H_2O_2 levels absorbance at 240 nm, according to Aebi (1984). Peroxidase (POD, EC 1.11.1.7) activity was determined according to protocol described by Polle et al. (1994).

The activity of superoxide dismutase (SOD, EC 1.15.1.1) was quantified by the nitro blue tetrazolium (NBT) reduction method as outlined by Giannopolitis and Ries (1977). One unit of SOD activity was taken as the level of enzyme needed to reduce 50% of NBT photoreduction, with absorbance at 560 nm. The activity of enzyme was calculated in units per milligram of protein, and total protein was estimated by Bradford method (1976) using BSA (bovine serum albumin) as the standard.

Peroxidase (POD; EC 1.11.1.7) activity was quantified according to Polle et al. (1994). Results were expressed as units/mg of protein, with one unit being equal to the amount of enzyme that catalyzes the oxidation of 1 μmol of ascorbate per minute per milligram of protein. Polyphenol oxidase (PPO; EC 1.14.18.1) activity was determined according to Oktay et al. (1995). The assay mixture was prepared with 100 μL of crude enzyme extract, 600 μL of catechol, and 2.3 mL of 0.1 M phosphate buffer, (pH 6.5). The absorbance at 420 nm was measured at the beginning and after one minute, with one unit of PPO defined as the amount of enzyme producing an increase of 0.001 in absorbance per minute. The enzyme activities were measured per milligram of protein, with the protein level assessed using Bradford assay with BSA as the standard protein. The ascorbate peroxidase (APX; EC 1.11.1.11) activity was measured following the method of Nakano and Asada (1981), which involves measuring decline in absorbance at 290 nm as a consequence of ascorbate oxidation, with extinction coefficient of 2.8 mM^{-1} cm^{-1}.

Malondialdehyde content (MDA)

The MDA content was analyzed using modified thiobarbituric acid assay using the method reported by Du and Bramlage (1992). Leaves were frozen using liquid nitrogen and then homogenized using 80% ethanol. Centrifugation of the samples was carried out at 6,000 rpm for 5 minutes at 2 mL microcentrifuge tubes. The sample extract (0.7 mL) was mixed with 0.7 mL of 0.65% TBA solution containing 20% TCA and 0.01% BHT, and another sample extract of

0.7 mL was mixed with 0.7 mL of 20% TCA and 0.01% BHT. Samples were then incubated at 95°C for 25 minutes, followed by cooling. The samples were re-centrifuged at 6,000 rpm for 5 minutes. Absorbance readings were recorded at wavelengths of 440, 532, and 600 nm. The MDA content was quantified using extinction coefficient of 157 $mM^{-1} \cdot cm^{-1}$.

Membrane stability, and total phenol content

Fresh leaves after 50 days of sowing were used for estimating membrane stability using the method outlined in the research paper of Lutts et al. (1996). For determining total phenolic compounds, the method of Bessada et al. (2016) was used.

Statistical analysis

Data were subjected to analysis of variance (ANOVA), and differences among treatments were considered statistically significant at $p \leq 0.05$. All analyses were conducted using the COSTAT software package (CoHort Software, 1986). Comparisons of treatment means were performed utilizing Duncan's multiple range test (Duncan, 1995).

RESULTS AND DISCUSSION

Hydrogen peroxide and superoxide anion content

As shown by the results presented in Figure 1, it was found that the level of H_2O_2 and $O_2^{\bullet-}$ in leaves under the influence of two salinity levels was markedly higher than in the control, and the rise was more pronounced at higher level of salinity. Thus, the content of H_2O_2 was higher by 51.72 and 84.73%, and $O_2^{\bullet-}$ was higher by 115.03 and 210.36% under two salinity stress conditions, respectively. On the contrary, the use of molasses significantly minimized the deposition of H_2O_2 and $O_2^{\bullet-}$ in wheat seedlings under salinity stress relative to non-treated stressed plants. The diminishment of H_2O_2 was 22.64 and 27.58%, and $O_2^{\bullet-}$ was 33.49 and 19.03% under two salinity stress conditions, respectively.

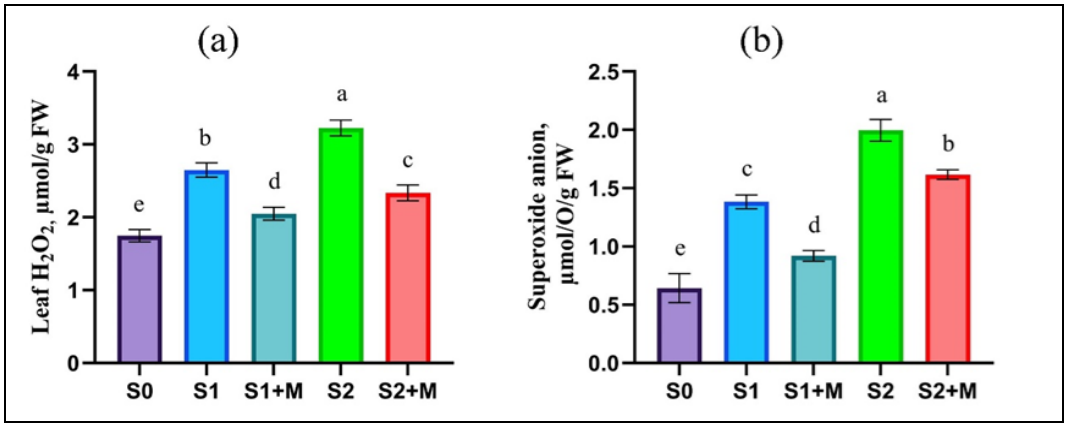

Figure 1. Influence of molasses application at 0.5 ml per pot on Leaf H_2O_2 content (a) and superoxide anion content (b) in wheat seedlings under two salinity treatments (S1: 4000 mg L^{-1} and S2: 6000 mg L^{-1}) compared with the non-saline control (S0). Bars sharing different letters demonstrate statistically significant variation across treatments at $p \leq 0.05$, according to Duncan's multiple range test.

Antioxidant enzymes activity

Figure 2 illustrates that the activities of various AE (SOD, CAT, APX, and POD) showed significantly improve under both degrees of salinity stress relative to the unstressed treatment (S0), while higher increases in enzyme activities were recorded under the higher level of salinity stress. For instance, the enzyme activities increased by 27.37% and 32.20% for SOD, 67.56% and 173.32% for CAT, 35.55% and 119.50% for APX, and 75% and 187.50% for POD under the two levels of salinity stress, respectively. Moreover, the application of molasses caused

significant increases the AE activities versus the unstressed plants when exposed to salinity stress. For instance, the enzyme activities increased by 11.59% and 14.88% for SOD, 34.32% and 15.94% for CAT, 39.59% and 40.65% for APX, and 28.15% and 37.60% for POD under the two levels of salinity stress, respectively.

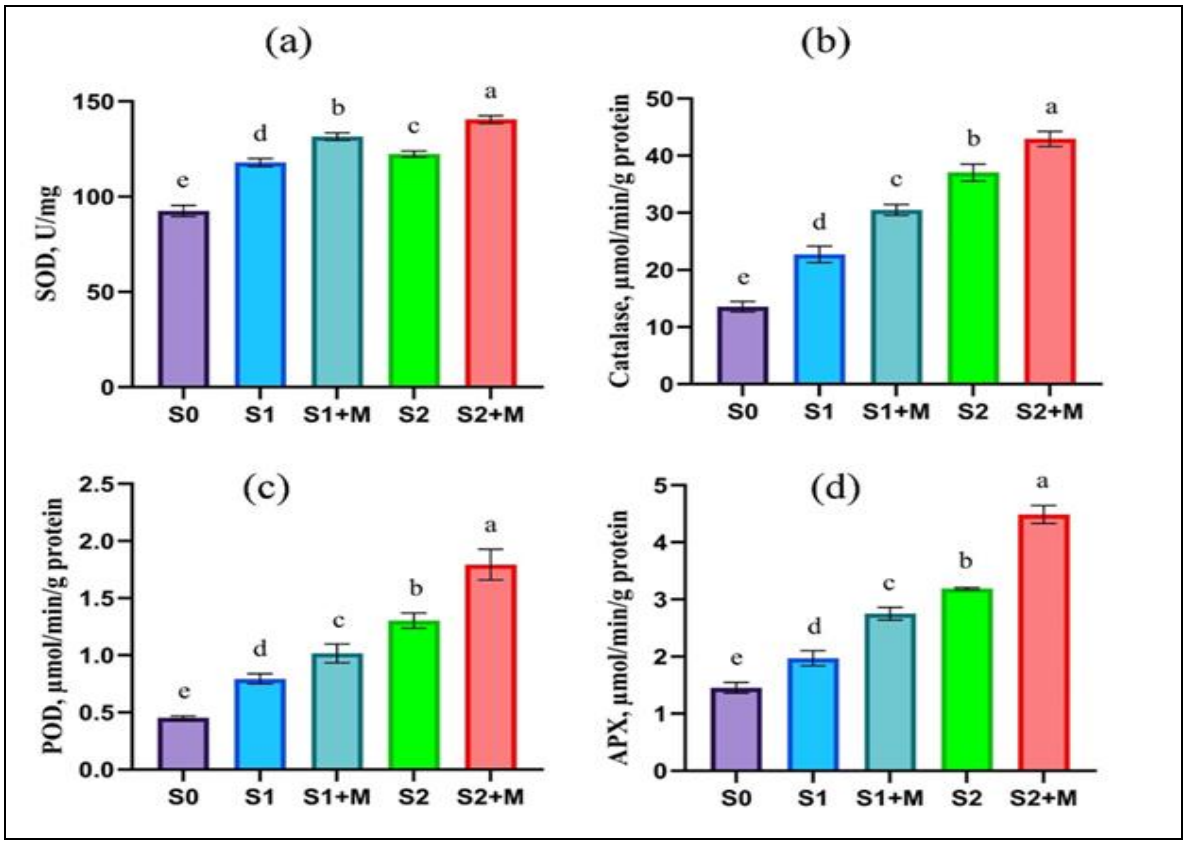

Figure 2. Influence of molasses application at 0.5 ml per pot on antioxidant enzymes activity including superoxide dismutase; SOD (a), catalase (CAT) (b), peroxidase; POD (c) and ascorbate peroxidase; APX (d) in wheat seedlings under two salinity treatments (S1: 4000 mg L^{-1} and S2: 6000 mg L^{-1}) compared with the non-saline control (S0). Bars sharing different letters demonstrate statistically significant differences across treatments at $p \leq 0.05$, according to Duncan's multiple range test.

Polyphenol oxidase activity and total phenol content

According to the data presented in Figure 3, PPO activity and leaf total phenol content were significantly higher in treated plants with both salinity levels relative to the control. Polyphenol oxidase activity was higher by 175.19% and 392.25%, while total phenol content was higher by 31.02% and 75.93% for the two salinity levels, respectively. However, the application of molasses significantly decreased polyphenol oxidase activity in salt-stressed seedlings compared to stressed untreated seedlings by 48.59% and 61.42% for the two salinity levels, respectively. Conversely, molasses application further enhanced the total phenol content in leaves by 22.44% and 20.13% compared to stressed untreated seedlings for the two salinity levels, respectively.

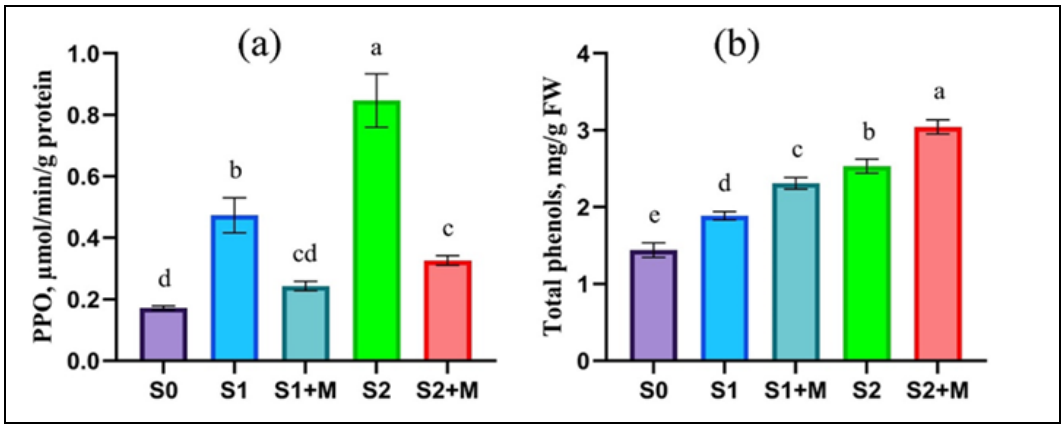

Figure 3. Influence of molasses application at 0.5 ml per pot on polyphenol oxidase activity; PPO (a) and leaf total phenol content (b) and membrane stability (b) in wheat seedlings under two salinity treatments (S1: 4000 mg L^{-1} and S2: 6000 mg L^{-1}) compared with the non-saline control (S0). Bars labeled with different letters denote differences among treatments that are statistically significant at $p \leq 0.05$, according to Duncan's multiple range test.

Malondialdehyde content and membrane stability index

The findings in Figure 4 demonstrate that the level of MDA was significantly elevated under saline conditions versus the unstressed control. The increase was more pronounced under the high level of salinity. The content of MDA increased by 31.91% and 52.52% under the two levels of salinity, respectively. On the other hand, the membrane stability index (%) was significantly reduced under salinity stress. It decreased by 25.57% and 43.67% compared with the unstressed control in both SSS conditions, respectively. Conversely, molasses treatment significantly decreased the effects of salinity on membrane injury. It reduced the content of MDA by 17.48% and 7.46% and improved the membrane stability index by 20.51% and 38.86% versus stressed plants at both salinity levels.

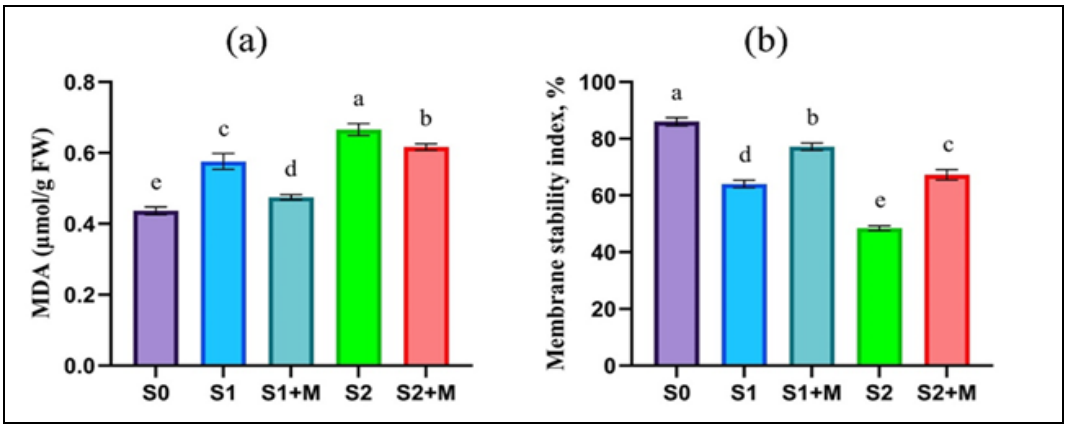

Figure 4. Influence of molasses application at 0.5 ml per pot on malondialdehyde; MDA (a) and membrane stability index (b) in wheat seedlings under two salinity treatments (S1: 4000 mg L^{-1} and S2: 6000 mg L^{-1}) compared with the non-saline control (S0). Different letters above bars indicate statistically significant differences among treatments ($p \leq 0.05$) according to Duncan's multiple range test.

The results revealed that salinity stress results in an overproduction of ROS to be produced in wheat seedlings, which are very harmful to cells and may cause cell death due to OS (Caverzan et al., 2016). Most ROS originate in chloroplasts, mitochondria, and peroxisomes when electron transport chains are disturbed. Excessive amounts of Na^+ and Cl^- ions are deposited in the cells under saline conditions, which triggers ionic imbalance in cells. This may increase the amount of ROS, including $O_2^{\bullet-}$ and H_2O_2 (El-

Beltagi et al., 2023; Farooq et al., 2024). Excessive ROS causes an increase in lipid peroxidation, which may cause cell membranes to deteriorate. In particular, superoxide radicals can react with membrane polyunsaturated fatty acids, giving rise to MDA. Therefore, the level of MDA is considered a dependable indicator of OS, as an increase in MDA concentration may cause severe cell damage, which may impair growth performance along with improving stress tolerance (Ma et al., 2015).

During salinity stress, wheat seedlings respond by increasing activities of major AE, namely SOD, CAT, APX, and POD, etc., with the aim of scavenge the excessive production of ROS in response to SSS. The antioxidant defense system of salt-tolerant wheat cultivars is higher compared to salt-sensitive wheat cultivars. This is due to the fact that salt-tolerant (ST) wheat cultivars are able to maintain lower ROS levels compared to salt-sensitive (SS) wheat cultivars (Abbas et al., 2022). In contrast, SS wheat cultivars show lower antioxidant enzyme activities compared to ST wheat cultivars. This results in higher ROS production in SS wheat cultivars compared to ST wheat cultivars, leading to higher malondialdehyde (MDA) content and lower membrane stability index (Gupta and Goyal, 2017).

Along with enzymatic defenses, exposure to salinity stress stimulates the production of phenolic compounds (flavonoids, tannins, and lignin) in wheat seedlings. Phenolic compounds play a role as non-enzymatic antioxidants, as they have directly participated in the neutralization of ROS and lipid peroxidation inhibition. The increase of phenols has a positive role in improving the stability of membranes by decreasing ion leakage, as well as improving osmotic regulation by accumulating phenolic compounds in the vacuole and increasing antioxidant activity. Similar to the role of enzymatic compounds, salt-tolerant wheat cultivars have higher phenolic compound content compared to salt-sensitive wheat cultivars, indicating their higher ability to tolerate salinity stress (Gupta and Goyal, 2017).

Salinity stress causes a considerable increase in polyphenol oxidase (PPO) activity in wheat seedlings. Polyphenol oxidase is an enzyme that catalyzes the oxidation of phenolic compounds into quinones, which then polymerize to form lignin. In salinity stress, the PPO activity increase is useful for the detoxification of ROS through phenol oxidation and for cell rigidity through lignin synthesis. However, this increase in PPO activity might lower the content of phenols available for antioxidant activities. PPO activity is also directly related to stress intensity. Higher concentrations of NaCl induce stronger PPO activities (Pungin et al., 2023).

Prolonged and severe salinity stress causes wheat seedlings to activate their AE and accumulate phenolic compounds. However, the protection is not full and becomes less effective with escalating stress severity, resulting in damage (Quitadamo et al., 2021). The application of molasses reduces the injury caused by salinity stress by promoting activities of major AE such as SOD, CAT, POD, PPO, and APX, and non-enzymatic antioxidants such as phenols, resulting in the reduction of the amount of ROS and protecting the cell structures (Awaad, 2023). Besides, molasses provides readily available carbohydrates, potassium, magnesium, sulfur, and micronutrients that activate plant metabolism as well as beneficial microorganisms (Dang et al., 2024). It also provides an increased level of potassium, which increases the K^+/Na^+ ratio, reducing toxicity, maintaining membrane stability, and ionic homeostasis under saline conditions (Chakraborty et al., 2018). Carbohydrates present in the molasses also play a crucial role as osmolytes, which increase osmotic adjustment, maintaining cell turgidity, as well as reducing dehydration stress (Choudhary et al., 2023). Moreover, organic matter present in the molasses also helps in the chelation of important nutrients like Ca^{2+}, Mg^{2+}, and K^+, which increases nutrient availability (Koźmińska et al., 2021). Additionally, the role of molasses as a source of carbon for beneficial soil microorganisms enhance soil structure, nutrient content, and growth hormones, which help plants withstand

salinity stress. Overall, all these processes prove that molasses indeed acts as a bio-stimulant for plants during salinity stress since it improves osmotic adjustment, ionic balance, antioxidant system, beneficial microorganisms, and nutrient content, which improves membrane stability (Salwan et al., 2019).

In summary, Figure 5 highlights the main outcomes of this study, demonstrating that both salinity levels significantly increased the deposition of ROS (H_2O_2 and $O_2^{\bullet-}$) and malondialdehyde (MDA), resulting in cell membrane injury and impaired cell integrity. Conversely, molasses application alleviated these adverse effects by enhancing the activities of AE and promoting the accumulation of non-enzymatic antioxidants, particularly total phenolic compounds, thereby preserving membrane stability.

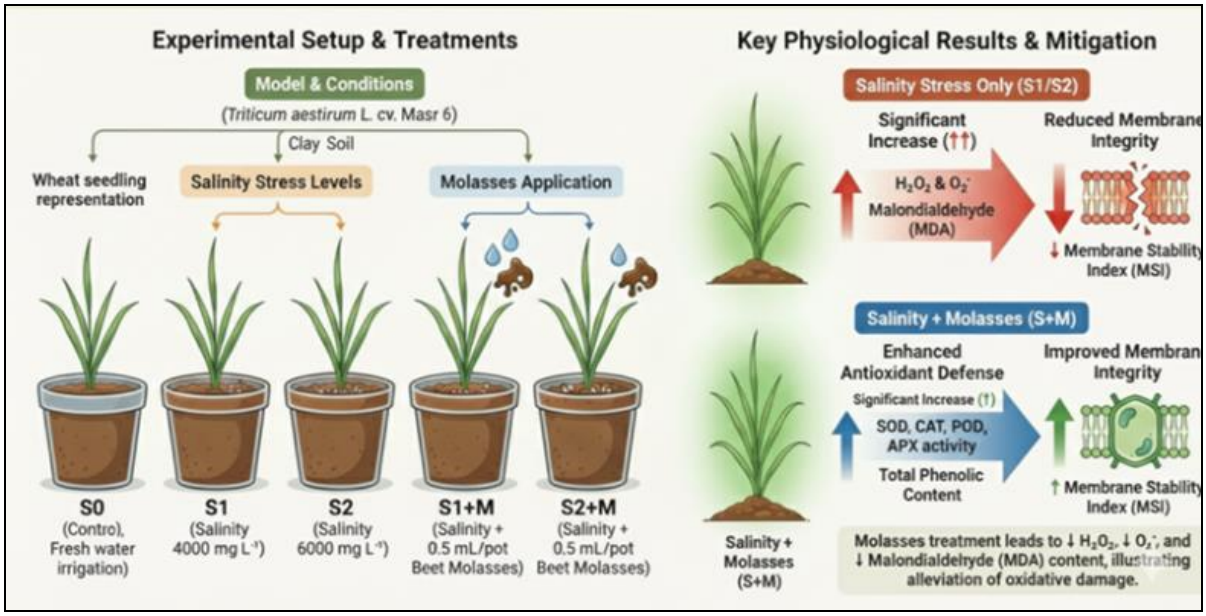

Figure 5. Conceptual diagram illustrating the effects of soil-applied molasses (0.5 mg L^{-1} per pot), applied alone or in combination with two salinity stress levels (S1: 4000 mg L^{-1} and S2: 6000 mg L^{-1}), on the deposition of reactive oxygen species (H_2O_2 and $O_2^{\bullet-}$), malondialdehyde (MDA), total phenolic compounds, antioxidant enzyme activities including superoxide dismutase (SOD), catalase (CAT), peroxidase (POD), and ascorbate peroxidase (APX) and membrane stability index (MSI), compared with unstressed, untreated wheat seedlings (S0).

CONCLUSIONS

Accordingly, the findings of this study demonstrate that, soil amendment with beet molasses alleviated the adverse impacts of salinity stress on cellular membranes of wheat seedlings by increasing the activities of antioxidant enzymes and the synthesis of non-enzymatic antioxidants such as total phenolic compounds.

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