

Study on the Effect of Aspirin Treatment to Improve the Growth of Maize Plants Exposed to Low Temperatures

Rabha Buhwish Hamad ^{1*}, Ahlam Abdalla Alaila ²

^{1,2} Department of Botany, Faculty of Science, Omar Al-Mukhtar University, AL-Bieda, Libya

دراسة عن تأثير المعاملة بالأسبرين لتحسين نمو نباتات الذرة المعرضة لدرجات حرارة منخفضة

رابحة بوحويش حمد ^{1*}، أحلام عبد الله العيلة ²
^{2,1} قسم علم النبات، كلية العلوم، جامعة عمر المختار، البيضاء، ليبيا

*Corresponding author: rabha.buhwish@omu.edu.ly

Received: March 26, 2026

Accepted: June 13, 2026

Published: June 28, 2026

Abstract:

The purpose of the research to assess how aspirin solution affected Zea mays L. plants' ability to withstand low temperatures. This study examined how aspirin solution affected the total carbohydrate content, photosynthetic pigments, and a few growth indices of Zea mays L plants under cold stress. Three alternative planting dates were used for cultivation. The first planting date was July 22, 2024, with a temperature of 30 ± 2 °C. November 22, 2024, was the second planting date, and the temperature was 15 ± 2 °C. At a temperature of $10C^0 \pm 2C^0$, the third planting date was January 22, 2025. Irrigation took place every other day during the 21-day cultivation period. Each group was split into two halves, one of which was irrigated with 100 milliliters of distilled water and the other with 100 milliliters of a 0.5 mM of aspirin solution. Plants were taken after 21 days, and measurements were made of fresh and dry biomass, photosynthetic pigments, carbohydrate, root length and shoot height. This study suggested that maize plants are susceptible to cold by showing decreased growth metrics at low temperatures. The findings of the research demonstrated that cold-stressed maize plants grew better following treatment, showing that aspirin solution administration increased the plants' resistance to chilly weather.

Keywords: Maize plant, Cold Stress, Aspirin, Growth indicators, Photosynthetic pigments, Carbohydrate content.

المخلص

حيث هدفت هذه الدراسة إلى تقييم تأثير محلول الأسبرين على قدرة نباتات الذرة (Zea mays L.) على تحمل درجات الحرارة المنخفضة. فحصت الدراسة تأثير محلول الأسبرين على إجمالي محتوى الكربوهيدرات، وأصبغ التمثيل الضوئي، وبعض مؤشرات النمو لنباتات الذرة تحت ظروف الإجهاد البارد. استُخدمت ثلاثة مواعيد زراعية بديلة. كان الموعد الأول في 22 يوليو 2024، عند درجة حرارة 30 ± 2 درجة مئوية. أما الموعد الثاني فكان في 22 نوفمبر 2024، عند درجة حرارة 15 ± 2 درجة مئوية. وفي الموعد الثالث، كان في 22 يناير 2025، عند درجة حرارة 10 ± 2 درجة مئوية. وتم الري يوميًا بعد يوم خلال فترة الزراعة التي استمرت 21 يومًا. قُسمت كل مجموعة إلى نصفين، رُوِيَ أحدهما بـ 100 مل من الماء المقطر، والآخر بـ 100 مل من محلول الأسبرين بتركيز 0.5 مللي. أُخذت عينات من النباتات بعد 21 يومًا، وقُيسَت الكتلة الحيوية الطازجة والجافة، وأصبغ التمثيل الضوئي، ومحتوى الكربوهيدرات، وطول الجذور، وارتفاع السيقان. أشارت هذه الدراسة إلى أن نباتات الذرة حساسة للبرد، حيث أظهرت انخفاضًا في مؤشرات النمو عند درجات الحرارة المنخفضة. أظهرت نتائج البحث أن نباتات الذرة المعرضة للبرد نمت بشكل أفضل بعد المعالجة، مما يدل على أن المعالجة بالأسبرين زادت من مقاومة النباتات للطقس البارد.

الكلمات المفتاحية: نبات الذرة، الإجهاد الناتج عن البرد، الأسبرين، مؤشرات النمو، أصبغ التمثيل الضوئي، محتوى الكربوهيدرات.

Introduction

Cold stress is an environmental factor that significantly impacts agricultural yields and the geographic distribution of numerous plant species, [1]. Temperature-induced stress is divided into two categories: (a) freezing stress (below 0°C), which leads to ice grains forming inside plant tissues, and (b) cold stress, where low temperatures

(0–15°C) are among the most significant factors affecting plant productivity and distribution [2]. Plant resistance to cold is influenced by specific structural and biochemical modifications that take place throughout cold acclimation [3]. whereas certain plants are susceptible to cold exposure, it influences many processes, such as dividing cells, photosynthesis, developmental stages, metabolism, lowers yield [4].

Maize (*Zea Mays L.*) plants are significant grain crop [5]. Due to its high nutritional value, corn pills are a rich source of biologically active plant compounds like carotenoids, phenols, and sterols, since maize has become the most prolific grain crop due to its global spread, it is a vital supply of food and commonly produced crop in worldwide cultivation [6]. Cooling temperatures inhibit development, germination, and the overall productivity of the many crops. Maize (*Zea Mays L.*) plant is sensitive to low temperatures, the ideal temperature range for maize plant growth is between 30 and 35 C⁰ [7].

Aspirin (marketed under the brand name ASA), When applied externally, which is similar to salicylic acid, undergoes automatic salicylic acid aqueous breakdown and transforms into acetyl salicylic acid [8]. . many studies on acetyl salicylic acid pure ,Because may stimulate the crop's systemic protection, acetyl salicylic acid is one of the primary chemicals that activate plant defenses [9] *Phaseolus vulgaris L.* strengthens acetylic acid for cold strain [10]. Additionally, acetyl salicylic acid lessened the detrimental effects of dehydration on barley plants [11]. Many physiological processes are regulated by salicylic acid (SA), a common phenolic signal molecule [12]. Numerous physiological processes have been reported to be affected by the external Salicylic acid apply, such as increased resistance to cold in pepper [13], bearing cooling in cucumber [14], carrying saline in barley [15], reduced suppressive impact of stress caused by drought on tomato and beans [16], and greater resilience against excessive metal exposure toxicity in barley [17]. "[18]" suggested that SA activates the capacity to handle stress, rather than directly acting as a protective factor.

In this study, we investigated whether applying aspirin to maize plants has beneficial effects similar to those of salicylic acid. Therefore, we believed that aspirin solution has similar effects improve plant growth and reduce the effects of stress on them. This experiment aimed to test the possibility the use of Aspirin solution to reducing the detrimental impact of low temperature on maize (plants sensitive to cold). This is achieved by highlighting the impact of cold temperatures on some growth indicators, photosynthetic pigments, total carbohydrate content in maize plant and then focusing on the role of aspirin solution in improving maize (*Zea Mays L.*) plant's resistance to cold stress.

Material and methods

Getting the solution ready we first grind aspirin tablets before dissolving them in distilled water because they are poorly soluble in water. After grinding, we made a 0.5 mM aspirin solution by dissolving aspirin powder in distilled water. Seed The agriculture faculty, Omar Al Mukhtar University provided the maize (*Zea mays L.*) seeds, which were chosen for their consistent size, shape, and colour. The seeds surface sterilized by immersing them in 4% (w/v) sodium hypochlorite for two minutes before being repeatedly cleaned by distilled water. The seeds were moved into soil-filled plastic pots with a diameter of 20 cm. Each pot had five seeds that sprouted, and the pots were left in their natural light and dark environments. Three distinct planting dates were used for the planting: The initial planting date was July 22, 2024, at a temperature of 30C⁰ ± 2. The temperature was 15C⁰ ± 2 on November 22, 2024, the second planting date. The third planting date was January 22, 2025, with a temperature of 10C⁰ ± 2. We split each group into two sections, one receiving 100 milliliters of distilled water and the other receiving 100 milliliters of 0.5 mM aspirin solution. Planting took place for 21 days, with watering occurring every two days. After 21 days, the plants were harvested, thoroughly cleaned of any adhering soil particles, gently plotted, dissected into shoots and roots, and their growth parameters, fresh biomass, and photosynthetic pigments were determined. In order to maintain weight and estimate the dry biomass and carbohydrate contents, additional samples were dried at 60C⁰.

Root length (RL) and Shoot height (SH) estimated using measurements taken to the closest centimeter.

Calculating dry biomass (d.m.) and fresh biomass (f.m.): Fresh biomass was obtained by weighing the shoots and roots of three replicates of identical plants. Dry biomass was calculated after the materials were oven-dried at 60°C until constant weight, then weighed.

Identification of pigments involved in photosynthetic processes:

The spectrophotometric technique [19] was used to extract and identify the photopigments carotenoids (Carot.) and chlorophyll a and b (Chl. A, Chl. B). Fresh leaves weighing around 0.5 g were ground in 85% (v/v) acetone in total darkness to remove the pigments .following centrifugation, and absorbance measured using a spectrophotometer (JENWAY 6305, UK) at three wavelengths: 665, 647, and 453 nm.

Calculation of carbohydrates components:

Calculating the TAC (available carbohydrate content): A boiling tube was filled with 100 mg of plant material that had been oven-dried. After adding 10 milliliters of 0.7 N hydrochloric acid, the mixture was boiled for half an hour. The volume of the aqueous solution was measured after it was neutralized to the phenol red endpoint [20], 5 ml of strong sulphuric acid, 1 ml of 5% phenol, and 2 ml of sugar extract were rapidly added. After ten minutes, the tubes were gently shaken and submerged in a water bath at 30°C for ten to twenty minutes. A wavelength of 490 nm was used to measure the absorbance. The amount of sugar (mg/g-1 dm) was determined by drawing a calibration curve using pure glucose.

Calculating Total Soluble Sugars (TSS): A boiling tube containing 5 ml of the sample extract and 5 ml of 1 N hydrochloric acid was put in a boiling water bath for 60 minutes. Phenol red was then added to the endpoint to convert the hydrolysate to a specified volume. The previously published procedure was used to convert a 2 ml sample to glucose.

Determination of Polysaccharides (St.): Also known as starch content (St.), this was calculated using the discrepancies between total soluble sugars and total accessible carbohydrates.

Statistical Analysis

Excel 2019 was used for statistical analysis of the findings, and ANOVA was utilized to compare independent samples, T-test was utilized to determine the significant differences between the means ($p < 0.05$).

Results

Changes in root length and shoot height

In this study, exposing maize plants to low temperatures led to a considerable reduction in growth, it is evident that when cold stress increased, maize plants' root length and shoot height dramatically dropped. (Figure 1) In comparison to the control (30C⁰±2), the root length of maize plants cultivated at 15C⁰±2 and 10C⁰±2 decreased by 31% and 63%, respectively. In comparison to the control, the corresponding shoot height values reduce by 29% and 74%, respectively, indicating that the maize plant is susceptible to cold. When plants were irrigated with aspirin solution as opposed to untreated plants, the drop in plant length was considerably reversed. Plants cultivated at (15± 2 C⁰) in the presence of aspirin solution had increases in root length and shoot height that were 1.28 and 2.0 times greater, respectively, than those grown at (15C⁰± 2) in the absence of aspirin solution. Also, Plants cultivated at (10± 2 C⁰) in the presence of aspirin solution had increases in root length and shoot height that were 1.5 and 2.3 times greater, respectively, compared to untreated plants at same temperatures (10C⁰± 2) figure (1).

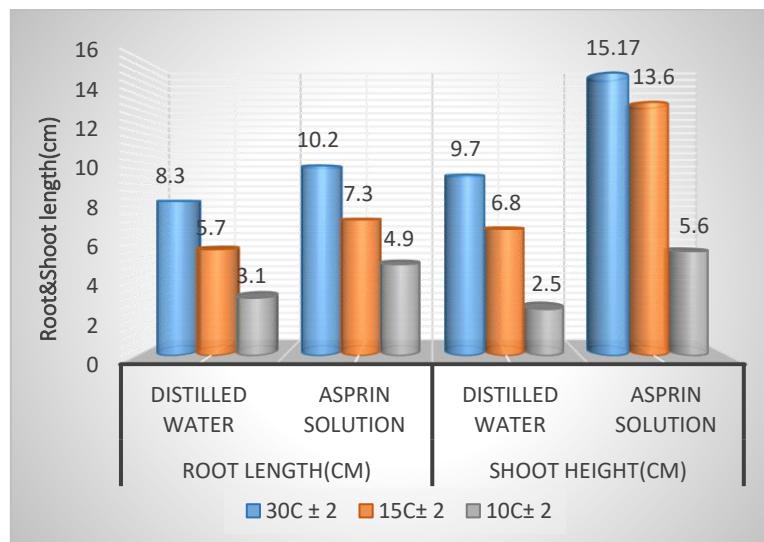


Figure 1: Effect cold stress and treatment by aspirin solution on the root length (cm) and shoot height (cm) of maize (*Zea mays* L.) plants.

Variations in dry (d. m.) and fresh (f. m.) biomass

When compared to the control, the fresh and dry biomass of the roots and leaves of maize plants was significantly reduced when cold stress was increased by low temperatures. After 21 days, fresh biomass in the roots of plants cultivated at 15C⁰± 2 and 10C⁰± 2 was reduced by 56% and 89%, respectively, compared to the control (30C⁰± 2). The comparable values for dry biomass were 65% and 84%, respectively. Simultaneously, At the same time, the reduction in fresh biomass in leaves at (15C⁰± 2) and (10C⁰± 2) was 32% and 87%, respectively compared to

control. The corresponding values for dry biomass were 34% and 66% respectively (Table 1). Addition of aspirin solution resulted increase of f.m. and d.m. of roots and leaves of Maize plants, compared to those grown in absence of aspirin solution. however, increasing in f.m. and d.m. were significantly less than of controls (Table 1). The increase in f.m. of roots and leaves at (10C⁰± 2) in presence of aspirin solution, was 3.4- and 3.7-fold respectively compared to in untreated plants at (10C⁰± 2) These results reveal that supplementation with **aspirin solution** could shift of the inhibitory effect of cold stress

Table 1: Effect cold stress and treatment by aspirin solution on the fresh and dry biomass (g/plant) in roots and leaves of maize plants.

Temperatures	Treatments	Root		Leaf	
C ⁰	aspirin solution (mM)	f.m	d.m	f.m	d.m
30C ⁰ ± 2	0	2.68±0.24 ^c	0.51±0.02 ^b	4.18±0.37 ^b	0.38±0.03 ^{ab}
30C ⁰ ± 2	0.5	5.31±0.44 ^a	0.63±0.05 ^a	7.09±0.59 ^a	0.43±0.04 ^a
15C ⁰ ± 2	0	1.18±0.09 ^d	0.18±0.02 ^d	2.83±0.21 ^c	0.25±0.01 ^{bc}
15C ⁰ ± 2	0.5	4.07±0.34 ^b	0.27±0.02 ^c	5.84±0.49 ^b	0.32±0.03 ^b
10C ⁰ ± 2	0	0.28±0.02 ^e	0.08±0.01 ^e	0.56±0.04 ^d	0.13±0.01 ^c
10C ⁰ ± 2	0.5	0.95±0.07 ^d	0.20±0.01 ^d	2.07±0.16 ^c	0.29±0.02 ^{bc}
<i>P</i>		0.001*	0.013*	0.002*	0.030*

P-value: was significant at P≤0.05 probability level

Changes in Photosynthetic Pigment Content

Changes in Photosynthetic Pigment Content

The results clearly showed a significant decrease in total photosynthetic pigments, chlorophyll a (Chl.a), and chlorophyll b (Chl.b) content with decreasing temperatures (Table 2), particularly at 10C⁰± 2.

At 15C⁰± 2 and 10C⁰± 2, the decrease in total photosynthetic pigment content was 15% and 47%, respectively, compared to the control sample. This decrease is mainly attributed to the reduction in chlorophyll a content.

After 21 days of the experiment, the decrease in chlorophyll a in the leaves at 15C⁰± 2 and 10C⁰± 2 was 25% and 68%, respectively, compared to the control sample. Comparing the treated plants with the untreated plants, we found an increase in chlorophyll a content: the increase was 1.27-fold at 15C⁰ and 1.38-fold at 10C⁰± 2, we also found an increase in chlorophyll b content: the increase was 1.31-fold at 15C⁰± 2 and 1.37-fold at 10C⁰± 2.

Unlike chlorophyll, we found that carotenoids increased with decreasing temperature (Table 2), with carotenoid content increasing 1.75- and 2.01-fold, respectively, at 15C⁰± 2 and 10C⁰± 2 compared to the control sample. This confirms the role of carotenoids as antioxidants in plants under stress.

However, carotenoid content decreased in plants treated with aspirin solution compared to untreated plants. Carotenoid content decreased by 29% at 10C⁰± 2 in the presence of aspirin solution compared without aspirin solution. This may indicate an enhanced defense mechanism against photo-oxidation in the presence of aspirin solution.

Table 2: Effect cold stress and treatment by aspirin solution on photosynthetic pigments (mg g⁻¹ f.m.) in leaves maize (*Zea mays* L.) plants.

Temperatures	Treatments	photosynthetic pigment			
C ⁰	aspirin solution (mM)	Chl.a	Chl.b	Carot.	Total
30C ⁰ ±2	0	32.76±1.93 ^b	11.64±0.67 ^b	5.41±0.49 ^c	49.81±3.20 ^b
30C ⁰ ± 2	0.5	43.75±2.41 ^a	13.02±0.77 ^a	4.46±0.37 ^d	61.23±3.51 ^a
15C ⁰ ± 2	0	24.57±1.21 ^c	8.26±0.59 ^c	9.51±0.63 ^a	42.34±2.43 ^{bc}
15C ⁰ ± 2	0.5	31.29±1.61 ^b	10.87±0.63 ^b	5.68±0.41 ^c	47.84±2.6 ^{bc}
10C ⁰ ± 2	0	10.18±0.85 ^e	4.95±0.38 ^e	10.91±0.68 ^a	26.04±1.84 ^c
10C ⁰ ± 2	0.5	14.03±0.77 ^d	9.45±0.55 ^d	7.65±0.48 ^b	31.13±1.7 ^d
<i>P</i>		0.003	0.0012	0.009	0.0021*

P-value: was significant at P≤0.05 probability level

Modifications the components of carbohydrates

Information displayed in Table 3. Shows that as low temperatures rise, the total accessible carbohydrate (TAC) and starch (St) content in the leaves and roots of treated and untreated maize plants decreases, the values attained in treated plants were higher than those in the absence of aspirin treatment. In comparison to controls, the (TAC) content of leaves and roots at (10C⁰±2) decreased by 51% and 62%, respectively, at the end of the experiment. For (St), the comparable values were 84% and 88%, respectively. Total soluble sugars (TSS) content of leaves and roots in the presence or absence of aspirin solution was considerably higher than controls, in contrast to the trend of (TAC). When aspirin solution was not present, the amount of TSS in the leaves and roots increased by 1.66 and 1.44 times, respectively, at 15C⁰±2. When aspirin solution was present at (15C⁰±2), the amount of TSS in the leaves and roots increased by 1.41 and 1.1 times, respectively, in comparison to the controls. (Table 3) demonstrates how soluble carbohydrates contribute to the development of strategy mechanisms as osmo protectant agents.

Table 3: Effect cold stress and treatment by aspirin solution on carbohydrates content (mg g⁻¹ d.m.) in leaves and roots.

Temperatures C ⁰	Aspirin Solution (mM)	Leaves			Roots		
		TSS	St	TAC	TSS	St	TAC
30C ⁰ ± 2	0	25.59±2.84 ^c	65.73±5.48 ^a	91.32±10.15 ^a	20.36±1.70 ^b	46.43±4.64 ^a	66.79±6.07 ^a
30C ⁰ ± 2	0.5	29.43±2.26 ^b	68.61±6.24 ^a	98.04±7.54 ^a	24.57±1.89 ^b	46.67±3.89 ^a	71.24±5.09 ^a
15C ⁰ ± 2	0	42.54±3.55 ^a	15.79±1.44 ^c	58.33±4.49 ^c	29.34±2.93 ^a	33.35±3.03 ^b	62.69±5.70 ^a
15C ⁰ ± 2	0.5	41.45±3.19 ^a	34.64±2.66 ^b	76.09±8.45 ^b	25.83±2.15 ^b	39.18±3.01 ^b	65.01±5.42 ^b
10C ⁰ ± 2	0	34.55±2.66 ^b	10.49±1.17 ^c	45.04±4.50 ^d	20.07±1.54 ^b	5.40±0.42 ^c	25.47±1.96 ^c
10C ⁰ ± 2	0.5	46.17±5.13 ^a	20.68±1.72 ^c	67.15±6.10 ^c	29.10±2.24 ^a	9.67±0.81 ^d	38.77±2.77 ^d
P		0.0078*	0.001*	0.003*	0.037*	0.002*	0.006*

P-value: was significant at P≤0.05 probability level

Discussion

This study showed a substantial reduction in root length and shoot height (Figure 1) In comparison to the control group (Table 1), maize plants exposed to low temperatures as well as a drop in fresh and dry biomass of maize roots and shoots. Additionally, this study showed that under cold stress, total photosynthetic pigment content and total carbohydrate content decreased (Table 2 and Table 3). For the best growth, plants require a consistent range of temperatures, which varies depending on the species. This is because plants are sensitive to cold temperatures (<10–15°C) [7], Thus, one of the main abiotic factors that can endanger plant growth and productivity is cold stress [21].

Plants farmed at low temperatures endure physiological and molecular alterations. in photosynthetic efficiency, and in the lipid content of bio membranes, which resulted in membrane breakdown, and variations in intracellular calcium levels were all detected in plants exposed to chilly stress [22]. Cell membrane destruction is the principal detrimental consequence of cold, it has been proven that the presence of saturated fatty acids in the cell membrane of cold-sensitive plants hinders plant growth and production, cold stress is associated with disruption of cellular organelle integrity due to reduced protein construction, photosynthesis, and metabolic activities. [23, 24], Reduced protein and enzyme activity has been reported in certain additional investigations [25]. Plastids, thylakoid membranes, mitochondria, and thylakoid protein phosphorylation are examples of ultrastructural changes [26] Aspirin, also referred to as acetylsalicylic acid (ASA), shares a chemical structure with ASA. The effects of SA and ASA on stress-exposed plants have been the topic of several research investigations: SA and ASA enhance resistance to stress in tomato and bean plants, carried out this investigation [16]. Additionally, ASA improves photosynthesis and antioxidant capacity while strengthening bean plants' resistance to cold stress when ASA is applied, antioxidant enzyme activities are markedly elevated [10]. Sweet pepper seeds germinate and emerge more readily at low temperatures when ASA and methyl jasmonate are added to the preparation solution [13], Additionally, a study by [11] used acetylsalicylic acid to boost barley plant development and lessen the detrimental effects of water stress. According to all of these research, acetylsalicylic acid is the essential substance for boosting plant defenses. When plants are under stress, the accumulation of salicylic acid (SA) raises the degree of growth inhibition. Additionally, numerous plants, including potatoes, rice, maize, and others, showed improved cold tolerance when acetylsalicylic acid was applied [27].

This study compared to untreated plants under cold stress, the current investigation showed that treatment with 0.5 mM aspirin solution boosted the growth factor in treated maize plants (Figure 1). treated plants had higher

total pigment and total carbohydrate contents (Tables 2, 3). photosynthesis is a crucial mechanism in plants under cold stress, photosynthetic efficiency frequently declines, which restricts a plant's capacity to absorb carbon and control water. Reactive oxygen species (ROS), which are produced as a result of cold stress, oxidatively damage lipids, proteins, and cell membranes. There are several physiological and biochemical effects of salicylic acid, such as controlling photosynthesis in plants growing in stressful or normal environments [28]. Acetylsalicylic acid (ASA) has unclear effects on photosynthesis while salicylic acid (SA) is known to reverse stomatal closure caused by abscisic acid (ABA), ASA may lessen the symptoms of cold injury in early maize plants, because it produces the energy required for growth and development, [29]. Therefore, improving plant resilience and efficiency requires an understanding of how treatments like ASA affect photosynthesis during stress. Since cold stress dramatically decreased photosynthetic efficiency and plant membrane stability, Aspirin solution increased the maize seedlings' resistance to cold stress in this study. Acetyl Salicylic Acid (ASA) and acetic acid have been demonstrated to reduce these adverse impacts. Decreasing stomatal conductance and compromising chlorophyll stability, cold stress usually lowers photosynthesis [30].

This study showed that higher photosynthetic parameters can be maintained by using aspirin solution under cold stress, indicating that aspirin solution protects photosynthesis. Additionally, it can maintain carotenoids and chlorophyll (chlorophyll a, chlorophyll b), which are vital elements for energy conversion and light absorption. This is in line with research showing that SA can improve the use of light energy by stabilizing the photosynthetic machinery [31, 32]. Salicylic acid also enhanced the quantity of chlorophyll a while maintaining the amount of chlorophyll. The work demonstrating that salicylic acid therapy can minimize oxidative damage and photoinhibition under demanding conditions further supported this outcome [33].

Low temperatures had an impact on several carbohydrate components in both treated and untreated maize plants, as Table 3 illustrates. Overall, as low temperatures increased, the total accessible carbohydrate (TAC) and starch (St) contents in the leaves and roots of both treated and untreated maize plants declined significantly; The Importance of soluble carbohydrates in creating a strategic mechanism as osmoregulatory is demonstrated by the higher TSS concentration in leaves and roots (Table 3), both in the presence and absence of aspirin solution. This study's finding of an increased soluble sugar content in the presence of aspirin solution indicates that the plants' resilience to cold stress was enhanced. However, the values attained in treated plants were higher than those not treated with aspirin. Because they can function as osmoregulatory, carbohydrates and their metabolism are known to be transiently sensitive to low temperatures. "[21, 29]" increasing chlorophyll, enzyme activity, and stomatal conductance, Salicylic acid treatment improves photosynthesis and raises carbohydrate content. In this also the results in our study reported increase in photosynthetic rates and the buildup of soluble sugars and starch. **aspirin solution** mainly promotes plant development and relieves stress, enhancing plant defenses mechanisms and cellular functioning, while large quantities may be inhibitory under specific stress situations.

Conclusion

In this study, maize plants exposed to cold temperatures showed a significant reduction in shoot height and root length. Biomasses of roots and leaves, both fresh and dry. Additionally, the content of total photosynthetic pigments dropped; this suppression was mostly caused by a decrease in the content of Chl.a. In contrast, the content of total carotenoids in maize leaves grew consistently, whereas the content of total carbohydrates fell under cold stress. When aspirin solution was applied, the growth parameters of treated maize plants increased in comparison to untreated plants. Additionally, the treated plants' total pigment content increased due to an increase in Chl a. And also report increase in total carbohydrate content of treated maize plants.

Recommendations

Suggestions Future research is required to determine proteins and antioxidant enzymes, as well as to use varied aspirin solution concentrations and ascertain the ideal **aspirin solution** concentration to offer the best defense against cold stress.

References

- [1] M. Aslam, B. Fakher, M. A. Ashraf, Y. Cheng, B. Wang, and Y. Qin, "Plant low-temperature stress: Signaling and response," *Agronomy*, vol. 12, no. 3, p. 702, 2022.
- [2] V. Devi, A. Kaur, M. Sethi, and G. Avinash, "Perspective chapter: effect of low-temperature stress on plant performance and adaptation to temperature change," in *Plant abiotic stress responses and tolerance mechanisms*: IntechOpen, 2023.
- [3] T.-H. Hsieh *et al.*, "Heterology expression of the Arabidopsis C-repeat/dehydration response element binding factor 1 gene confers elevated tolerance to chilling and oxidative stresses in transgenic tomato," *Plant physiology*, vol. 129, no. 3, pp. 1086-1094, 2002.
- [4] A. S. Lukatkin, A. Brazaitytė, Č. Bobinas, and P. Duchovskis, "Chilling injury in chilling-sensitive plants: a review," 2012.

- [5] T. M. El-Katony, Z. M. El-Bastawisy, and S. S. El-Ghareeb, "Timing of salicylic acid application affects the response of maize (*Zea mays* L.) hybrids to salinity stress," *Heliyon*, vol. 5, no. 4, 2019.
- [6] R. Goering, S. Larsen, J. Tan, J. Whelan, and I. Makarevitch, "QTL mapping of seedling tolerance to exposure to low temperature in the maize IBM RIL population," *Plos one*, vol. 16, no. 7, p. e0254437, 2021.
- [7] H. T. Nguyen, J. Leipner, P. Stamp, and O. Guerra-Peraza, "Low temperature stress in maize (*Zea mays* L.) induces genes involved in photosynthesis and signal transduction as studied by suppression subtractive hybridization," *Plant Physiology and Biochemistry*, vol. 47, no. 2, pp. 116-122, 2009.
- [8] A. Korkmaz, M. Uzunlu, and A. R. Demirkiran, "Acetyl salicylic acid alleviates chilling-induced damage in muskmelon seedlings," *Canadian Journal of Plant Science*, vol. 87, no. 3, pp. 581-585, 2007.
- [9] A. A. A. Barroso *et al.*, "Acetylsalicylic acid (ASA) as inductor of growth and flowering in tomato," *Scientific Electronic Archives*, vol. 15, no. 5, 2022.
- [10] M. H. Soliman, A. A. Alayafi, A. A. El Kelish, and A. M. Abu-Elsaoud, "Acetylsalicylic acid enhance tolerance of *Phaseolus vulgaris* L. to chilling stress, improving photosynthesis, antioxidants and expression of cold stress responsive genes," *Botanical studies*, vol. 59, no. 1, p. 6, 2018.
- [11] R. Kabiri and M. Naghizadeh, "Exogenous acetylsalicylic acid stimulates physiological changes to improve growth, yield and yield components of barley under water stress condition," *Journal of Plant Physiology and Breeding*, vol. 5, no. 1, pp. 35-45, 2015.
- [12] F. M. Shakirova, A. R. Sakhabutdinova, M. V. Bezrukova, R. A. Fatkhutdinova, and D. R. Fatkhutdinova, "Changes in the hormonal status of wheat seedlings induced by salicylic acid and salinity," *Plant science*, vol. 164, no. 3, pp. 317-322, 2003.
- [13] A. Korkmaz, "Inclusion of acetyl salicylic acid and methyl jasmonate into the priming solution improves low-temperature germination and emergence of sweet pepper," *HortScience*, vol. 40, no. 1, pp. 197-200, 2005.
- [14] H. M. Kang and M. E. Saltveit, "Chilling tolerance of maize, cucumber and rice seedling leaves and roots are differentially affected by salicylic acid," *Physiologia plantarum*, vol. 115, no. 4, pp. 571-576, 2002.
- [15] M. El-Tayeb, "Response of barley grains to the interactive effect of salinity and salicylic acid," *Plant growth regulation*, vol. 45, no. 3, pp. 215-224, 2005.
- [16] T. Senaratna, D. Touchell, E. Bunn, and K. Dixon, "Acetyl salicylic acid (Aspirin) and salicylic acid induce multiple stress tolerance in bean and tomato plants," *Plant Growth Regulation*, vol. 30, no. 2, pp. 157-161, 2000.
- [17] A. Metwally, I. Finkemeier, M. Georgi, and K.-J. Dietz, "Salicylic acid alleviates the cadmium toxicity in barley seedlings," *Plant physiology*, vol. 132, no. 1, pp. 272-281, 2003.
- [18] T. Senaratna, D. Merritt, K. Dixon, E. Bunn, D. Touchell, and K. Sivasithamparam, "Benzoic acid may act as the functional group in salicylic acid and derivatives in the induction of multiple stress tolerance in plants," *Plant Growth Regulation*, vol. 39, no. 1, pp. 77-81, 2003.
- [19] H. Metzner, H. Rau, and H. Senger, "Untersuchungen zur synchronisierbarkeit einzelner pigmentmangelmutanten von *Chlorella*," *Planta*, vol. 65, no. 2, pp. 186-194, 1965.
- [20] T. Murata, T. Akazawa, and S. Fukuchi, "Enzymic mechanism of starch breakdown in germinating rice seeds I. An analytical study," *Plant Physiology*, vol. 43, no. 12, pp. 1899-1905, 1968.
- [21] A. Theocharis, C. Clément, and E. A. Barka, "Physiological and molecular changes in plants grown at low temperatures," *Planta*, vol. 235, no. 6, pp. 1091-1105, 2012.
- [22] P. J. Seo *et al.*, "Cold activation of a plasma membrane-tethered NAC transcription factor induces a pathogen resistance response in Arabidopsis," *The Plant Journal*, vol. 61, no. 4, pp. 661-671, 2010.
- [23] M. A. Hannah, D. Wiese, S. Freund, O. Fiehn, A. G. Heyer, and D. K. Hincha, "Natural genetic variation of freezing tolerance in Arabidopsis," *Plant physiology*, vol. 142, no. 1, pp. 98-112, 2006.
- [24] F. Kaplan and C. L. Guy, "β-Amylase induction and the protective role of maltose during temperature shock," *Plant physiology*, vol. 135, no. 3, pp. 1674-1684, 2004.
- [25] E. Ruelland and A. Zachowski, "How plants sense temperature," *Environmental and experimental botany*, vol. 69, no. 3, pp. 225-232, 2010.
- [26] M. Matteucci, S. D'Angeli, S. Errico, R. Lamanna, G. Perrotta, and M. M. Altamura, "Cold affects the transcription of fatty acid desaturases and oil quality in the fruit of *Olea europaea* L. genotypes with different cold hardiness," *Journal of experimental botany*, vol. 62, no. 10, pp. 3403-3420, 2011.
- [27] J. C. Cuevas *et al.*, "Putrescine is involved in Arabidopsis freezing tolerance and cold acclimation by regulating abscisic acid levels in response to low temperature," *Plant physiology*, vol. 148, no. 2, pp. 1094-1105, 2008.
- [28] W. Khan, B. Prithiviraj, and D. L. Smith, "Photosynthetic responses of corn and soybean to foliar application of salicylates," *Journal of plant physiology*, vol. 160, no. 5, pp. 485-492, 2003.
- [29] L. Manasa S, M. Panigrahy, K. C. Panigrahi, and G. R. Rout, "Overview of cold stress regulation in plants," *The Botanical Review*, vol. 88, no. 3, pp. 359-387, 2022.

- [30] A. Bhattacharya, "Effect of low temperature stress on photosynthesis and allied traits: A review," *Physiological processes in plants under low temperature stress*, pp. 199-297, 2022.
- [31] M. Moustakas, I. Sperdouli, J. Moustaka, B. Şaş, S. İşgören, and F. Morales, "Mechanistic insights on salicylic acid mediated enhancement of photosystem II function in oregano seedlings subjected to moderate drought stress," *Plants*, vol. 12, no. 3, p. 518, 2023.
- [32] I. Sperdouli, E. Panteris, J. Moustaka, T. Aydın, G. Bayçu, and M. Moustakas, "Mechanistic insights on salicylic acid-induced enhancement of photosystem II function in basil plants under non-stress or mild drought stress," *International Journal of Molecular Sciences*, vol. 25, no. 11, p. 5728, 2024.
- [33] B. Ali *et al.*, "Exogenous acetylsalicylic acid mitigates cold stress in common bean seedlings by enhancing antioxidant defense and photosynthetic efficiency," *Frontiers in Plant Science*, vol. 16, p. 1589706, 2025.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of **AJAPAS** and/or the editor(s). **AJAPAS** and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.