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The Influence of Temperature on Poaceae: A Systematic Review on Physiological Responses and Agricultural Implications

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Abstract: Temperature remains a significant abiotic factor influencing plant growth, development, and overall productivity. This systematic review examines the physiological responses of 30 Poaceae species to varying temperature conditions, focusing on evaluating how each species adapts to extreme thermal stress. By performing the PRISMA analysis and Checklist, relevant literature was critically analyzed to identify significant patterns and trends in plant responses. 10 selected studies were reviewed and revealed plants response including germination mean time (GMT), seed germination percentage (SGP), and bio-active compound changes. The result shows that between 20-25°C, most Poacaea species maintain growth and development, suggesting an optimal temperature range. Productivity of these species were manifested in their high seed germination percentage and lower germination mean time. Despite optimal conditions, 10 exceptional species were found to have positive affinity with extreme temperatures. 7 species exhibited cold resistance at temperatures between 5 and 15°C. This was further supported by their high SGP and GMT under these conditions. Meanwhile, 3 species were able to thrive at temperatures between 30 and 40°C, suggesting their greater heat tolerance among the species studied. Understanding these responses is essential for agricultural sustainability and climate adaptation strategies. The identification of highly adaptable species can be instrumental in developing climate-resilient crops, optimizing growth conditions, and enhancing productivity in changing environments. Additionally, certain Poaceae species may serve as bio-indicators for temperature fluctuations, contributing to environmental monitoring and ecological conservation efforts. Future research should explore genetic and molecular mechanisms governing temperature adaptability to improve breeding programs and ensure food security in the face of climate change.

Keywords: *Climate Change, Germination Percentage, Germination Time, Photsynthetic Efficiency.*

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I. INTRODUCTION

Temperature is one of the most critical environmental factors influencing plants' physiology, altering growth and development patterns. It plays a key role in various physiological processes, including seed germination, photosynthesis, respiration, and enzyme activity (Roberts, 1988). However, with the onset of global warming, temperature fluctuations change at an unpredictable rate, significantly impacting plants' productivity. While heat waves are becoming more extreme (Meehl, et al., 2007), little to no further research has been conducted on the effect of mean annual temperature on plants' productivity (Kumudini et al., 2014). This systematic review focuses on the role of temperature on *Poaceae* species on their growth and development patterns as well as their evolutionary resilience against extreme temperatures evidenced by collected studies.

The Gramineae or Poaceae family is widely utilized for its economic significance in agriculture, contributing to food security in most tropical regions. Their grassy characteristics associated with nutritional value branded themselves as primary food sources for a significant portion of the global population. The leading species include rice (*Oryza sativa)*, wheat (*Triticum aestivum)*, and maize (*Zea mays).* Although there is extensive research on the effects of temperature on plant development, there remains a lack of consensus regarding the optimal temperature thresholds for different species within the Poaceae family. Some studies suggest that rising temperatures accelerate phenological stages (Keller, 2020), hence introducing invasive tendencies of grass species, while others indicate that extreme heat stress reduces grain filling (Sun, 2023) and biomass accumulation (Wu, 2022). Conversely, a study on soybeans by Gong (2021) revealed a 50% delay in maturity under frigid conditions. Furthermore, scarcity of the area of concern attributes to in situ or geographical regions or laboratory experiments, which inhibit holism in understanding grass specie complexities. With these, a systematic synthesis is necessary to give clarification to longstanding discrepancies and provide wide-scope knowledge of the effect of varying temperature on Poaceae species at different growth stages.

This review has four objectives. It aims to identify temperature ranges a species exhibits growth and development changes. This will include germination rate pattern (Wei, 2021; Wang, 2020; Khaeim, 2020; Li, 2024); changes in bio-active compound (Islam, 2021); biomass accumulation; and senescence (Iveland, 2023). This review paper determines the optimal conditions for a species' physiological responses to remain healthy. This will be evidenced by positive feedback as temperature increases or decreases. This review exposes the array of species that can survive temperature extremities supported by their physiological responses. This review will extend the representation of 30 selected species from included articles across agricultural and biodiversity studies to resolve knowledge gaps in grass species.

Moreover, this systematic analysis provides a fresh perspective on grass species beyond widely studied cultivars, accentuating their potential agricultural application. Understanding the characteristics of seed germination will aid in predicting species distribution and changes in community composition (Wang, 2020). Essentially, the bio-indicative potential aligned with the findings of studied grass species in this review can be extrapolated to predict climatic patterns and global warming. These insights will serve as a stepping stone to call for proactive solutions against this pressing environmental issue, prompting government agencies to devise efficient ways to mitigate their effects.

II. METHODOLOGY

To selectively gather all the relevant studies, a systematic approach was utilized. Adhering to the guidelines and recommendation of the PRISMA statement, the researchers followed an explicit and search strategies with inclusion and exclusion criteria.

➤ *Search Strategy*

Using Google Scholar, Web of Science, and Science Direct, a total of 100 records of related studies were collected. These studies focuses on the effects of temperature interventions on Poaceae species. The literature search was conducted on March 14 to 24, 2025.

➤ *Inclusion/Exclusion Criteria*

This strategy is established after discarding duplicates (n = 23) to ensure that the studies' relevance met the review's objectives. The articles under screening were assessed by three reviewers under these conditions: (1) studies must be published between year 2020 to 2025; (2) must be a scientific article published in journal in peer reviewed journal; (3) language used is English; (4) population of the study is mainly *Poaceae*; (5) the research article assess the effect of temperature on *Poaceae* species' physiological response.

Various studies were excluded because (1) they focused on assessing the effect of temperature not concerning *Poaceae* species (2) more than 2 interventions other than temperature have been applied (3) lacked strong evidence to support such claim on physiological responses of *Poaceae* species; (4) it further explores biotechnology beyond topic of interest (5) publication dates earlier than 2020 or not peer-reviewed

These limits set by the reviewers reduce bias in selection of the study while maintaining objectivity.

➤ *Methodological Quality Assessment*

The Johanna Briggs Checklist (JBI) is a tool used to assess the methodological quality of research studies. It consists of a set of criteria used to determine the rigour and validity of a study. When applying the JBI checklist, aspects such as study design, participant selection, data collection and analysis, among others, are analysed. The 37 identified articles were assessed for their methodological quality. The included studies were examined through a critical and independent review using an eleven-point checklist developed by Aromataris and Munn (Aromataris & Munn, 2020).

To minimize biases, the checklist was conducted by three researchers anonymously, with ignorance to the authors involved in the set of study under a checklist. This was implemented to prevent committing systematic errors from biases on assessment. The selected studies must meet at least 5 of the checklist criteria. The set of criteria is as follows:

- Is the purpose of research clearly specified?
- Does it expose physiological changes when temperature varies?
- Are the data extraction instruments appropriate?
- Are the results obtained provide useful insight to other related studies concerning *Poaceae*?
- Are those data extrapolated draw broader perspective on agricultural aspect?
- Does the author align their conclusion with objectives?

- Are those conclusions supported by the analysis of results
- Does the author suggest potential recommendation for further knowledge gaps recognized in the area of topic?

Upon evaluating, 27 studies were excluded based on the quality issues raised in the checklist, as they did not meet at least four of the criteria established by the researchers.

➢ *Selection of Studies*

A total of 100 article were recorded in the data base and using registers combined. The number was reduced to 77, after failing to eliminate duplicates. The 77 scientific articles were screened for their relevance based on critical assessment of their title and abstract. The number of records were further reduced to 37 as some articles did not provide access to the full content, hence some were not retrieved. 37 of remaining records managed to reach the Inclusion/Exclusion criteria. Consequently, the remaining articles undergoes methodological assessment where the researchers objectively assess their relevance through the use of JBI checklist. Ultimately, a total of 10 studies were eligible for the inclusion in this review (see Figure 1).

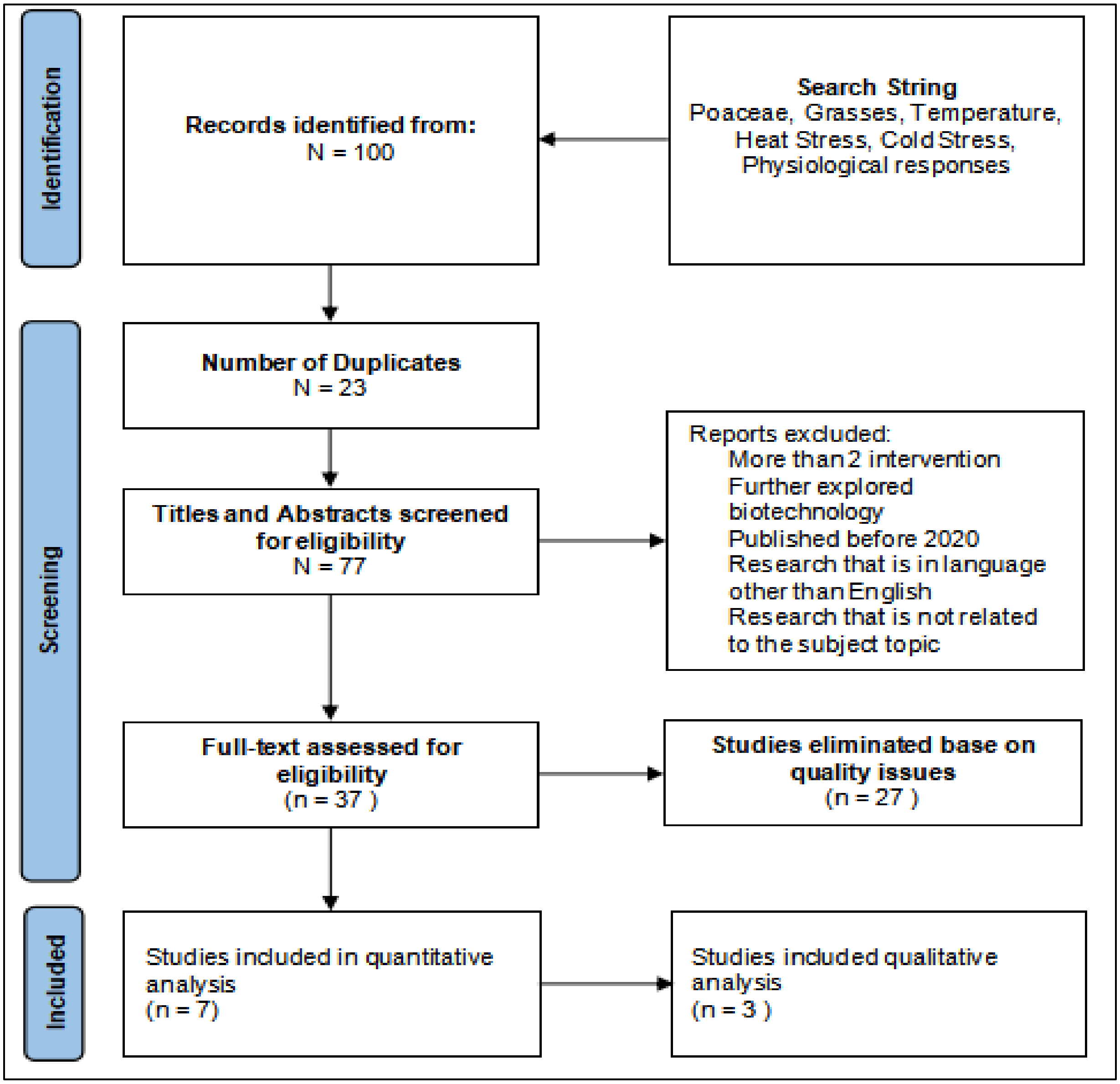

Fig 1. Flow Chart of Study Selection Process using PRISMA Method

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➢ *Study Area*

This review covers *Poaceae* species in 2 major continents including Asia and Europe. Half of the species studied were conducted mainly in China and Korea in category for cold resistant species such as Poa L. cluster. Some studies were performed in European countries such as in Denmark and Finland, which establishes an assessment on seed germination and growth patterns under variable conditions. Similarly, few studies in this review appropriated an approach beyond controlling measures. In central Tibet, China, a study aims to assess the germination rate of selected Poaceae seeds under the warming temperature of the region's climate. Furthermore, the selection of study area ensures that all temperature extremes were carefully incorporated to provide holistic perspective on each physiological response it corresponds to.

➢ *Data Sources*

Temperature intervention and growth trend analysis was primarily incorporated to conduct further testing in respect to determining the species' physiological responses. Studies included in this review establishes rigorous assessment of incremental treatment of temperature in both in situ and in vitro analysis with minor intervention to ensure other variables remained controlled. These data sources common in all selected studies, between 2020 and 2025, were extracted via strategic approach of utilizing Google Scholar, Science Direct, Web of Science associated with search techniques .

➢ *Sampling Procedure*

Studies on seed germination percentage and rate of selected species were primarily prepared through systematic techniques to ensure no extraneous variables could influence the experiment. Locations where samples have been collected were predetermined according to the average temperature based on day/night cycle with the less tendency of anomalies considering elevated habitat. Random selection through mapping were established in few studies focusing on phenotype plasticity to ensure representation per individual. A total of 30 *Poaceae* species were analyzed from included studies which were collected according to their seasonal growth for the entire study period. Some parameters considered were the moisture content, exposure to temperature, seed germination percentage, germination mean time, and photosynthetic efficiency.

➢ *Data Extraction*

In order to meet the objectives of the review, content analysis was carried out to the 10 scientific articles obtained. Data were extracted using a structured data collection form capturing: (1) study information; (2) *Poaceae* species; (3) temperature conditions; (4) growth parameters; (5) findings. This literature review provided indispensable accounts for specific area of interest concerning the effect of temperature on *Poaceae* species' physiological responses. Several records claimed that that responses of selected species may indicate climatic patterns in both cold and dry regions. Additionally, the review emphasizes the role of *Poaceae* species as bio-indicative to temperature patterns by manifestation of seedling growth rate, plasticity and photosynthetic efficiency.

Morever, a narrative synthesis was conducted to summarize trends through the use of graphs generated by Excel and Jamovi software to quantify the impact of temperature variations on the physiological responses. Consequently, qualitative analysis was formulated by extrapolating the data gathered and synthesizing the findings' implication within the dissected articles.

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III. RESULTS AND DISCUSSION

Table 1. Summary of Findings

Species	Temperature	Findings	Author & Year
Poa poophagorum	5°C - 20°C	This species exhibits moderate cold resistance, with some germination at 5°C, though not as strong as other species. It shows relatively high drought resistance, maintaining germination at -0.6 MPa, though germination declines at -1.2 MPa. Germination is faster under mild drought (-0.3 MPa).	**Wei, L., Zhang, C., Dong, Q., Yang, Z., Chu, H., Yu, Y., & Yang, X. (2021)**
Poa sinoglauca		It has moderate germination at low temperatures (5°C) and moderate drought resistance, with a significant drop in germination at -0.9 MPa and below. Germination indices remain moderate across different water potentials.	
Poa orinosa		Similar to *P. poophagorum*, it shows moderate cold resistance and relatively high drought resistance, germinating at -0.6 MPa but declining at -1.2 MPa. Germination is faster under mild drought (-0.3 MPa).	
Poa pagophila		This species has strong cold resistance, with high germination at 5°C, but only moderate drought resistance, declining sharply at -0.9 MPa. It germinates faster in cold conditions.	
Poa subfastigiata		It has poor cold resistance (no germination at 5°C) and moderate drought resistance, with germination declining at -0.9 MPa. It performs best under mild drought (-0.3 MPa).	
Poa megalothyrsa		Demonstrates strong cold resistance (high germination at 5°C) but moderate drought resistance, with germination dropping at -0.9 MPa. It germinates faster in cold conditions.	
Poa malaca		Shows strong cold resistance (high germination at 5°C) and moderate drought resistance, with significant declines at -0.9 MPa. Like other cold-resistant species, it germinates faster at low temperatures.	
Poa paucifolia		Exhibits moderate to strong cold resistance (germination at 5°C) and relatively high drought resistance, tolerating -0.6 MPa but declining at -1.2 MPa. Germination is faster under mild drought.	
Poa elanata		Has moderate germination at 5°C and moderate drought resistance, with significant declines at -0.9 MPa. Germination indices remain moderate across conditions.	
Poa sphondylodes		Displays strong cold resistance (high germination at 5°C) but moderate drought resistance, with declines at -0.9 MPa. It germinates faster in cold conditions.	
Poa crymophila cv. Qinghai		Shows moderate cold resistance but poor drought resistance, with sharp declines at -0.9 MPa. Germination indices are lower under drought stress.	
Poa pratensis var. anceps		Exhibits moderate cold resistance and relatively high drought resistance, germinating at -0.6 MPa but declining at -1.2 MPa. Germination is faster under mild drought.	
Poa pratensis cv. Qinghai		Similar to *Var. anceps*, it has moderate cold resistance and relatively high drought resistance, with germination at -0.6 MPa and faster germination under mild drought.	
Leymus chinensis	23°C, 29°C, and 32°C	Stress negatively affected plant growth and physiological functions of the plant species, reducing biomass, water status, photosynthesis, and nitrogen metabolism enzymes. However, it increased specific leaf area (SLA), protein degradation (endopeptidase), and oxidative stress (malondialdehyde). Photosynthetic efficiency was positively linked to soluble proteins and nitrogen enzymes but negatively correlated with protein breakdown and oxidative damage, suggesting that maintaining nitrogen metabolism helps sustain photosynthesis under stress.	**Xu, Z. Z., & Zhou, G. S. (2024).**
Triticum aestivum	10/5 °C, 20/15 °C, 30/25 °C	Optimal growth in terms of height, weight, and yield was observed at 20/15°C, while 10/5°C resulted in the poorest growth due to reduced	**Islam, M. Z., Park, B.-J., &**

	(day/night)	photosynthesis. However, despite slower growth, the 10/5°C condition significantly increased bioactive compounds, including total phenols, flavonoids, and vitamin C, likely due to stress-induced metabolic responses. Antioxidant activity (measured via ABTS and DPPH assays) and antioxidant enzyme levels (guaiacol peroxidase, catalase, and glutathione reductase) were also highest at 10/5°C, indicating enhanced stress defense mechanisms. Chlorophyll content peaked at 20/15°C, whereas carotenoids were highest at 10/5°C, suggesting a protective role against oxidative stress under cooler conditions.	**Lee, Y.-T. (2021)**
Hordeum vulgare		This plant species exhibited similar temperature-dependent responses, with the best growth (height, weight, and yield) occurring at 20/15°C, while 10/5°C inhibited growth. However, like wheat grass, barley grass grown at 10/5°C accumulated higher levels of phenolic compounds, flavonoids, and vitamin C, along with stronger antioxidant activity (ABTS and DPPH) and elevated antioxidant enzyme activity. Chlorophyll content was highest at 20/15°C, whereas carotenoid levels increased at 10/5°C, mirroring the trend seen in wheat grass. Although barley grass followed the same general patterns as wheat grass, it generally showed lower overall growth and phytochemical content across all temperature conditions.	
Stipa purpurea,	- Control Temperature mean annual (1.3 °C) - Optimal Temperature (15 °C) - Warming Temperature (+3 °C)	*Stipa purpurea* showed higher seed germination percentages (SGP) under both control (field-observed temperatures) and warming (+3°C) conditions compared to the optimal treatment (25/15°C), where germination decreased by 26%.	**Wang, X., Niu, B., Zhang, X., He, Y., Shi, P., Miao, Y., Cao, Y., Li, M., & Wang, Z. (2020)**
Stipa capillacea		*Stipa capillacea* exhibited a 4% increase in SGP under warming but an 11% decline under optimal temperatures, along with significantly shortened mean germination times (MGT) in both warming and optimal treatments.	
Festuca coelestis		*Festuca coelestis* displayed the highest SGP under control and warming, with a 15% reduction in germination under optimal conditions, while its MGT decreased under warming.	
Phragmites australis	12/10°C (day/night) 22/20°C (day/night) 32/30°C (day/night)	*Phragmites australis* exhibited significant clinal variations in photosynthetic traits, particularly under cold temperatures. High-latitude genotypes showed enhanced cold tolerance, with higher values for traits like photosynthetic capacity, and triose phosphate utilization (TPU). These genotypes also displayed lower phenotypic plasticity in physiological traits, suggesting stability in colder environments. In contrast, warm-adapted genotypes from lower latitudes struggled under cold stress, showing reduced photosynthetic performance. The integration of physiological traits was strongest under cold conditions, highlighting coordinated adaptations to preserve fitness.	**Mudiyanselage, O. B. (2024).**
Phragmites mauritianus		*Phragmites mauritianus* demonstrated similar patterns of temperature acclimation, with high-latitude genotypes performing better in cold environments. However, its responses were less pronounced compared to *P. australis*, possibly due to its tropical origins. The species showed moderate plasticity in photosynthetic traits, with weaker clinal patterns in warmer treatments. Trait integration was observed under stress, but the correlations were less robust than in *P. australis*.	
Phragmites frutescens		This species exhibited the least clinal variation among the three, with minimal latitudinal differences in photosynthetic traits. Its responses to temperature changes were more uniform, suggesting a narrower adaptive range. Phenotypic plasticity was lower overall, and trait integration was less pronounced, indicating fewer coordinated adaptations to environmental stress compared to the other two species.	
Lolium perenne	5°C	Atmospheric temperature significantly influenced canopy cover and soil pH, had a moderate effect on grass height, and a slight effect on forage	**Oshani Bamunu Mudiyanselage**

		weight, with optimal growth occurring above 5°C but heat stress causing browning. Pearson correlation analysis showed temperature impacts on growth parameters, with recovery possible through adequate rainfall.	**(2024)**
Zea mays	5°C - 40°C	*Zea mays* seeds germinated fastest at 20–35°C within 48 hours, with no germination at 5°C and 40°C, while seedling growth was optimal at 20°C, though extreme temperatures slowed it down. Water availability improved both germination and growth up to an optimal level, but high seed density reduced seedling growth due to competition.	**Khaeim, H., Kende, Z., Jolánkai, M., Kovács, G. P., Gyuricza, C., & Tarnawa, Á. (2022)**
Elymus dahuricus	5 °C, 15 °C, 25 °C	Germination was fastest at 25°C (6.67 ± 0.94% in 24h) and moderate at 15°C, with a significant delay at 5°C. It tolerated fast cooling better, showing minimal germination loss at -15°C, but a gradual decline to 50% at -20°C under slow cooling.	**Li, J., Jaganathan, G. K., Han, X., & Liu, B. (2024)**
Festuca elata		Germination was slowest among species, with 4.0 ± 0% at 25°C (84h delay) and significantly delayed at 5°C (156h start time). It was highly sensitive to freezing, with germination dropping sharply from -5°C to -10°C under slow cooling and 29.3% remaining at -20°C under fast cooling.	
Lolium multiflorum		Germination was fastest at 25°C (2.67 ± 0.47% in 24h) and slowed under lower temperatures, starting at 58h under 15°C. It showed the highest sensitivity to freezing, with a sharp decline to 45.33% at -15°C under fast cooling and a significant viability loss under slow cooling.	
Alopecurus ovatus	0.6°C - 2.1°C	Increased temperature delayed senescence onset and slowed green biomass loss during heating, though senescence rate showed no clear pattern after heating began. Heated treatments (3-heater & 6-heater) retained more green biomass than the control, while moisture had no significant effect.	**Iveland, C. (2023)**
Setaria pumila	40 °C - 120 °C	Relative seed mortality (RSM) was minimal at 40–60°C, with a maximum of 16.7% at 60°C for 90 min. RSM increased significantly at 80°C (64.6%) and reached 93.3% at higher temperatures.	**Šoštarčić, V., Pišonić, M., Pismarović, L., & Šćepanović, M. (2024)**

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This systematic review examined various studies with regard to temperature's effect on Poaceae plants, considering their physiological characteristics and agricultural impacts. The important results show that temperature is critical for seed germination, development, photosynthesis, and tolerance against stress among different Poaceae plant species.

Various Poaceae species respond differently to temperature fluctuations and drought, as evident from the findings of various studies. The findings illustrate how these plants cope with environmental stress in terms of germination, resistance to drought, and general growth. It also discusses species distribution, on the basis of the graphs, detailing how they are distributed and how they cope with varying climates. Temperature is a contributing factor in how well the species grow. Cold-tolerant species such as *P. malaca*, *P. megalothyrsa*, and *P. sphondylodes* retained their germination levels even at 5°C, while *P. subfastigiata* did not. Certain species, such as *P. poophagorum* and *P. orinosa*, coped with slight drought stress (-0.3 MPa) reasonably well but faltered with increasingly dry conditions (-1.2 MPa). The same trends were observed in *P. paucifolia* and *P. pratensis var. anceps*, indicating their tolerance to moderately arid environments.

Scientists subjected these species to controlled temperature and water levels. *Leymus chinensis* experienced decreased growth and photosynthesis under stress but coped by upregulating protective characteristics such as specific leaf area and markers for oxidative stress. By contrast, Triticum aestivum (wheat) and *Hordeum vulgare* (barley) performed best at 20/15°C but, upon exposure to 10/5°C, fortified antioxidant defenses. In contrast, *Stipa purpurea* and *Stipa capillacea* germinated well under mild warming (+3°C), but their germination percentages declined under what would otherwise be optimal conditions (15°C). When comparing the distribution of the species, those which occur in colder climates are also concentrated in high-latitude habitats. Phragmites australis, for instance, accommodated low temperatures successfully, and the species recorded great photosynthetic ability as well as steady physiological characteristics. *Phragmites mauritianus* tolerated fluctuating temperatures but was less tolerant compared to the former species, and *Phragmites frutescens* recorded least tolerance.

Studies conducted by ten researchers focused on how temperature and drought influence germination, growth, and stress resistance. Most species grew best in moderate temperatures (15–25°C), while extreme conditions—particularly freezing temperatures and prolonged drought—posed serious challenges.

➢ *Qualitative Results*

Table 2. Effects of Temperature on Poaceae Germination and Growth

Temperature range	Species	Observations
Low Temperature (5–15°C)	*Poa pagophila* *Poa megalothyrsa* *Poa malaca* *Poa sphondyllodes*	*Poa pagophila*, *P. megalothyrsa*, *P. malaca*, and *P. sphondyllodes*, exhibit strong cold resistance, maintaining high germination rates at 5°C.
	Poa subfastigiata	*P. subfastigiata* fails to germinate at 5°C, indicating its vulnerability to low temperatures.
	Triticum aestivum *Hordeum vulgare*	Wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) increase their production of phenols, flavonoids, and vitamin C at 10/5°C, suggesting that colder temperatures enhance metabolic responses despite reduced growth.
Optimal Temperature (20–25°C)	*Poa sphondyllodes* *Poa poophagorum*	*P. sphondyllodes* and *P. poophagorum* exhibit the highest adaptability at 20–30°C, making them suitable candidates for artificial grasslands under rising temperatures.
	Festuca coelestis	*Festuca coelestis* maintains stable germination rates at both control temperatures (1.3°C) and under experimental warming (+3°C), suggesting resilience to temperature fluctuations.
High Temperature (30–40°C)	*Leymus chinensis*	Extreme temperatures (above 30°C) negatively affect *Leymus chinensis*, reducing biomass, photosynthetic efficiency, and nitrogen metabolism at 32°C.
	Zea mays	*Zea mays* germinates rapidly at 20–35°C but fails to germinate at 40°C, indicating a clear threshold for its temperature tolerance.
	Alopecurus ovatus	*Alopecurus ovatus* exhibits extended green biomass retention under warming conditions, suggesting a potential advantage for Arctic herbivores like the Svalbard reindeer.

➢ *Implication of Findings*

The findings from this table highlight the diverse temperature tolerances and adaptive strategies of various plant species, which have significant implications for agriculture, conservation, and climate change resilience. Cold-resistant species like *Poa pagophila, P. megalothyrsa,* and cereals such as wheat and barley thrive in low temperatures (5–15°C), with enhanced metabolic responses that could inform breeding programs for frost-resistant crops. In contrast, *P. subfastigiata's* failure to germinate at 5°C underscores the vulnerability of some species to chilling stress. At optimal temperatures (20–25°C), *P. sphondyllodes* and *P. poophagorum* demonstrate high adaptability, making them promising candidates for artificial grasslands in warming climates, while *Festuca coelestis's* stable germination under fluctuating temperatures suggests resilience to climate variability. However, extreme heat (30–40°C) negatively impacts species like *Leymus chinensis* and *Zea mays*, reducing growth and germination, which could threaten productivity in warming regions. Conversely, Alopecurus ovatus benefits from higher temperatures, potentially supporting Arctic herbivores like the Svalbard reindeer through extended green biomass availability. These findings emphasize the need for targeted species selection in habitat restoration, agricultural planning, and climate adaptation strategies to ensure ecosystem stability and food security under changing thermal regimes.

➢ *Ecological and Agricultural Implications*

The qualitative findings underscore the critical role of temperature in determining the survival, distribution, and productivity of Poaceae species across diverse ecosystems. Cold-tolerant species like *Poa pagophila* and *P. megalothyrsa* thrive in alpine and low-temperature environments, while warm-adapted species such as *P. sphondyllodes* and *P. poophagorum* perform best in moderate to high temperatures. However, rising global temperatures pose a significant threat to heat-sensitive species like *Lolium multiflorum*, which exhibited high mortality under extreme heat, suggesting potential climate-induced habitat loss. These temperature-dependent responses highlight the vulnerability of certain Poaceae species to shifting climatic conditions, which could lead to altered species distributions and ecosystem imbalances.

From an agricultural perspective, temperature fluctuations present both opportunities and challenges. In colder regions, warming conditions may extend growing seasons, as seen in *Alopecurus ovatus*, which retains green biomass longer under elevated temperatures—potentially benefiting Arctic herbivores like reindeer. However, heat stress severely impacts key forage species such as *Leymus chinensis* and *Lolium perenne*, reducing biomass and photosynthetic efficiency, which could diminish grazing resources. Crops like *Zea mays*, while highly productive within optimal temperature ranges, face complete germination failure at extreme heat (40°C), raising concerns about food security in warming climates. These findings emphasize the need for adaptive agricultural strategies, including the selection of heat-resilient crop varieties and modified planting schedules.

The broader ecological implications of temperature-driven shifts in Poaceae communities could reshape grassland ecosystems and herbivore dynamics. If extreme temperatures favor certain species over others, grassland biodiversity may decline, disrupting ecological interactions and ecosystem services. For instance, prolonged growth of cold-adapted grasses like *Alopecurus ovatus* could alter Arctic grazing patterns, while heat-stressed species may struggle to persist in their native ranges. Although some Poaceae exhibit adaptive traits, the rapid pace of climate change may exceed their capacity for adjustment, leading to population declines and reduced ecosystem resilience. These findings call for proactive conservation measures, habitat management, and further research into species-specific thermal thresholds to mitigate the ecological and agricultural risks posed by global warming.

IV. CONCLUSION

This systematic review undescores the crucial part that temperature plays in the growth, development along with existence of Poaceae types, which are important for worldwide food security besides ecosystem balance. Main discoveries show that Poaceae types have differing sensitivity to temperature. Best germination and growth often happen between 20–25°C. Very high or low temperatures disturb physiological actions such as photosynthesis plus biomass gain but types like *poa sphondyllodes* besides *elymus dahuricus* are hardy to warmer plus colder settings.

The analysis underlines type-based changes, the creation of bioactive mixes in cold tolerant types besides delayed aging in heat tolerant types such as *alopecurus ovatus*, which lengthens growing times. Temperature shifts, worsened by climate change, make big problems for farm output, especially for key crops like maize and wheat, which see lowered grain fill plus biomass when heat becomes a problem. These shifts may cause changes in type spread, changed grassland make-up and effects on plant-eating animal groups, mostly in Arctic lands.

Despite existing research, gaps persist in understanding the relationships between temperature and other environmental stressors, such as water availability and soil conditions, on Poaceae species. Further research is necessary to expand studies to underrepresented species and regions. This analysis highlights the importance of temperature regimes in developing resilient agricultural systems and conservation strategies to safeguard food security and biodiversity in the face of a changing climate. Future research should prioritize investigating the relationships between temperature and other environmental stressors on Poaceae species, with a focus on underrepresented species and regions.

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