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A Bibliometric Analysis of Stress Memory and Priming in Plants: Research Trends, Mechanisms, and Implications for Agricultural Resilience

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Abstract: This bibliometric analysis explores research trends and collaborative networks surrounding the concepts of "stress memory" and "priming" in plants, with a focus on their implications for agricultural resilience. A total of 270 studies published between 2007 and 2024 were analyzed, revealing a growing interest in this relatively new area of plant science. While the global research output saw a slight decline in 2021, publication activity rebounded in 2024, reaching a peak of 51 documents in 2024. The majority of studies were published in *Frontiers in Plant Science*, and prominent authors such as Isabel Bäurle contributed significantly to the field. Co-authorship analysis highlighted strong international collaboration, particularly between Germany and China, with Germany emerging as the leading country in both publication volume and collaborative efforts. Keyword analysis indicated that "priming" was the most frequently used term, reflecting its central role in research on plant stress memory. The focus on genetic, epigenetic, and metabolic mechanisms provides valuable insights into how plants "remember" stress and adapt to recurring challenges. These findings underscore the multidisciplinary nature of the field, with contributions from plant physiology, molecular biology, and agricultural sciences. The results emphasize the importance of continued global collaboration and the integration of theoretical and applied research to develop climate-resilient crops. Furthermore, the high proportion of open-access publications highlights the increasing accessibility of this research, fostering wider dissemination and application of findings. This analysis provides a comprehensive understanding of the evolving landscape of stress memory and priming research, offering valuable directions for future studies aimed at enhancing agricultural sustainability and resilience.

Keywords: Stress memory; plant adaptation; priming; bibliometric analysis

1. Introduction

The study of stress memory in plants has gained prominence due to the escalating challenges posed by climate change and its impact on agricultural systems. Climate change increases the frequency and intensity of stress events such as droughts, heatwaves, and salinity, threatening global food security and agricultural productivity [1-3]. Understanding how plants retain and recall memories of past stress is essential for developing strategies to enhance crop resilience. A systematic review of existing literature on this topic is necessary to provide a comprehensive understanding of current research, identify knowledge gaps, and guide future studies aimed at advancing climate-resilient agricultural practices [4].

Priming is a phenomenon where plants exposed to mild or non-lethal stressors develop an enhanced ability to respond to subsequent stress. This process equips plants with a form of "stress memory," enabling faster and stronger responses to environmental challenges, such as drought, heat, or pathogen attacks [5]. Primed plants exhibit increased expression of defense-related genes, accumulation of signaling molecules, and activation of antioxidant systems. Stress memory refers to the ability of plants to "remember" past stress events, influencing their responses to future stress. This memory can be short-term (within the same generation) or long-term (transferred to progeny through epigenetic modifications). Epigenetic mechanisms, such as DNA methylation, histone modifications, and small RNAs, play a critical role in encoding and maintaining stress memory [6]. For example, drought exposure can induce modifications in drought-responsive genes, improving plant resilience to future water deficits.

Priming and stress memory hold significant potential for agriculture, as they can be harnessed to improve crop resilience and productivity in the face of changing climatic conditions. A bibliometric review of stress memory in plants offers valuable insights into research trends, identifies influential studies, and highlights the contributions of leading researchers and institutions [7-8]. By mapping the research landscape, such a review facilitates collaborations among scientists, accelerates advancements in the field, and supports the application of stress memory concepts in agriculture [9-10].

Despite advancements in understanding stress memory mechanisms, critical gaps remain. For instance, the molecular basis of transgenerational memory—where stress-induced traits are inherited by subsequent generations—remains inadequately understood [2,8]. Furthermore, research is needed to explore how different stress types, such as biotic (pathogen attacks) and abiotic (drought) stresses, influence memory formation via distinct pathways [11-12]. A bibliometric review can pinpoint these gaps, enabling researchers to focus their efforts on areas that promise significant breakthroughs in plant adaptation and resilience [4].

Understanding stress memory has practical implications for agricultural innovation and sustainable farming practices. By synthesizing research findings, a bibliometric review can translate theoretical insights into practical applications, such as priming techniques that enhance crop resilience to adverse conditions [2, 9]. These insights are crucial for breeding programs and biotechnological approaches aimed at creating crop varieties capable of withstanding climate pressures [13-14]. Additionally, such knowledge supports efforts to increase food production sustainably, minimizing reliance on chemical inputs like pesticides and fertilizers, which carry environmental and economic costs [4, 15].

Finally, a comprehensive review of stress memory literature serves as a valuable resource for researchers, policymakers, and agricultural practitioners. For scientists, it offers a clear overview of the research landscape, aiding both newcomers and established researchers in navigating the complexities of stress memory research [16]. For policymakers and practitioners, the review provides evidence-based insights for crop management strategies, guiding the development of agricultural practices that enhance productivity and resilience in the face of environmental challenges [2, 9].

1.1 Objectives of the Study

The study aims to conduct a comprehensive bibliometric analysis of stress memory and priming in plants, focusing on research trends, mechanisms, and implications for agricultural resilience. Specifically, the study aimed to: analyze publication trends and identify the journals in which the documents are published; identify and categorize the authors, their organizations, and their countries; identify the most frequently used keywords in publications related to the terms "stress memory," "priming," and "plants"; and conduct a bibliometric review of authors, subject areas, document types, source titles, publication stages, keywords, affiliations, countries, languages, and open access status.

1.2 Stress Memory in Plants

Plants, as sessile organisms, are continually exposed to fluctuating and often adverse environmental conditions such as drought, heat, salinity, and pathogen attack. Unlike animals, they cannot escape these stresses but have evolved sophisticated mechanisms to adapt and survive. One such adaptation is stress memory—the ability to "remember" previous stress events and respond more efficiently to subsequent exposures. This memory is encoded at molecular, cellular, and physiological levels, enabling plants to mount faster, stronger, or more specific responses to recurring or even novel stresses [10, 17, 18]. Stress memory serves as a cornerstone of plant resilience, with profound implications for natural ecosystems and agricultural productivity, particularly under climate change and increasing environmental variability [14, 19].

1.3 Mechanisms of Stress Memory Formation

1.3.1 Epigenetic Regulation

Stress memory in plants is primarily mediated through epigenetic mechanisms that regulate gene expression without altering DNA sequences. These include DNA methylation, histone modifications, and chromatin remodeling [16, 19, 20]. DNA methylation influences transcriptional activity and can be maintained through cell divisions, providing a stable molecular basis for memory [18]. Histone modifications, such as trimethylation of histone H3 lysine 4 (H3K4me3), are also vital for transcriptional memory, as they facilitate rapid gene reactivation following stress exposure [19, 21, 22]. Meanwhile, chromatin remodeling, involving changes in nucleosome positioning and accessibility, ensures the proper regulation and reactivation of stress-responsive genes [22-23].

1.3.2 RNA-Based Regulation.

RNA molecules play central roles in regulating plant stress memory. MicroRNAs (miRNAs) and small interfering RNAs (siRNAs) fine-tune gene expression through post-transcriptional regulation and RNA-directed DNA methylation (RdDM), respectively. Additionally, long non-coding RNAs (lncRNAs) guide protein complexes for epigenetic modification, further stabilizing transcriptional memory [17]. Alternative splicing (AS) and small regulatory RNAs also modulate gene networks that govern stress perception and response, contributing to the molecular retention of stress experiences [10].

1.3.3 Hormonal and Signaling Pathways.

Plant hormones such as abscisic acid (ABA), jasmonic acid (JA), ethylene (ET), salicylic acid (SA), auxins, and cytokinins orchestrate complex signaling cascades that influence physiological adaptations like stomatal regulation, osmotic balance, and growth modulation [24]. These hormones not only mediate immediate stress responses but also participate in establishing long-term signaling networks that contribute to stress memory [25].

1.3.4 Transcriptional Regulation.

A variety of transcription factors (TFs)—including those from the DREB, WRKY, NAC, and bZIP families—activate stress-responsive genes and facilitate memory formation [18, 25]. Such activation can lead to transcriptional memory, where plants "remember" prior stress exposure, allowing for a faster and more robust response during subsequent challenges [12].

1.3.5 Physiological and Biochemical Adjustments.

Stress memory also manifests at the physiological level. Priming, where prior exposure to mild stress enhances tolerance to later, more severe stress, involves biochemical and molecular adjustments that can persist throughout the plant's life or be transmitted to progeny [8, 30, 31]. Furthermore, autophagy, a self-degradative process, plays a role in resetting and modulating cellular memory by degrading damaged proteins and organelles [26].

1.4 Factors Influencing Stress Memory

The formation and persistence of stress memory are influenced by multiple factors. The type of stress determines the specific molecular and physiological pathways activated—drought, salinity, cold, and heat each trigger distinct regulatory mechanisms [27-29]. Moreover, the interaction of environmental conditions shapes the effectiveness of memory formation. For example, combined or sequential stresses (e.g., drought and high temperature) can induce cross-adaptation, where tolerance to one stress confers resistance to others [27, 29, 30].

1.5 Inheritance of Stress Memory

Stress memory can be retained at both the somatic and heritable levels. Somatic memory occurs within the lifespan of an individual plant, allowing adaptive responses to recurring environmental challenges [18, 24]. In contrast, intergenerational and transgenerational inheritance involves the transmission of epigenetic marks or molecular signals to progeny, predisposing them to enhanced stress tolerance [19]. This heritable memory provides an evolutionary advantage, as it enables offspring to anticipate and withstand environmental conditions experienced by their parents.

1.6 Applications and Future Directions

Understanding the molecular and physiological bases of stress memory opens new avenues for crop improvement and sustainable agriculture. Insights from epigenetic regulation, RNA-based control, and stress priming can be harnessed to develop crop varieties with enhanced stress resilience [31]. Moreover, breeding strategies informed by these mechanisms can accelerate the creation of stress-resistant cultivars, particularly through epigenetic selection and molecular breeding approaches [32].

Future research should prioritize identifying specific genes and pathways associated with stress memory, exploring the longevity and reversibility of epigenetic marks, and elucidating cross-talk among stress signaling networks [24,33]. Integrating these insights into agricultural practice could lead to crops capable of sustaining productivity under the increasing frequency of environmental stress events brought about by climate change.

2. Materials and Methods.

In this study, the Scopus platform, a widely recognized bibliographic database, was the primary tool for conducting a comprehensive bibliometric analysis of research on stress memory in plants. The Scopus database was selected for its extensive coverage of high-quality scientific literature and its advanced filtering and citation analysis capabilities.

The first step involved performing a keyword search in the Scopus database using terms such as: "stress memory" AND "priming" in combination with "plants” OR “crops” OR “vegetation". The search was conducted across all fields to ensure a broad capture of relevant articles, reviews, and conference papers. The search results were then filtered by the number of citations to focus on the most influential studies in the field. The first 270 records were retained with the highest number of citations for further analysis.

The resulting database of 270 records was then uploaded into VOSviewer version 1.6.18, a bibliometric software developed by Ness Jan van Eck and Ludo Waltman [34]. VOSviewer was used to perform several computations, including the identification of the most co-cited authors, the most frequently used keywords, and the development of co-occurrence maps. These analyses allowed us to visualize the relationships between various research themes and the evolution of knowledge on stress memory in plants.

The use of VOSviewer allowed for the creation of visual co-occurrence maps, which highlighted key areas of focus in the field, such as molecular mechanisms like DNA methylation, transcriptional regulation, and priming effects, as well as applications of stress memory in agricultural practices. The insights gained from this analysis informed future research directions and practical applications in developing climate-resilient crops.

3. Results and Discussion

3.1 Number of Published Studies on Priming and Stress Memory (2007–2024)

Figure 1 shows the number of published studies on priming and stress memory from 2007 to 2024. When searching for the terms "stress memory" and "priming" in combination with "plants," "crops," or "vegetation" in Scopus, the query returned a total of 270 results. The publication years ranged from 2007 to 2024, indicating that research on stress memory in plants is relatively recent. A slight decrease in the number of publications was observed in 2021, likely due to restrictions on human interaction during the COVID-19 pandemic. The year 2024 saw the highest number of publications, with a total of 51 documents.

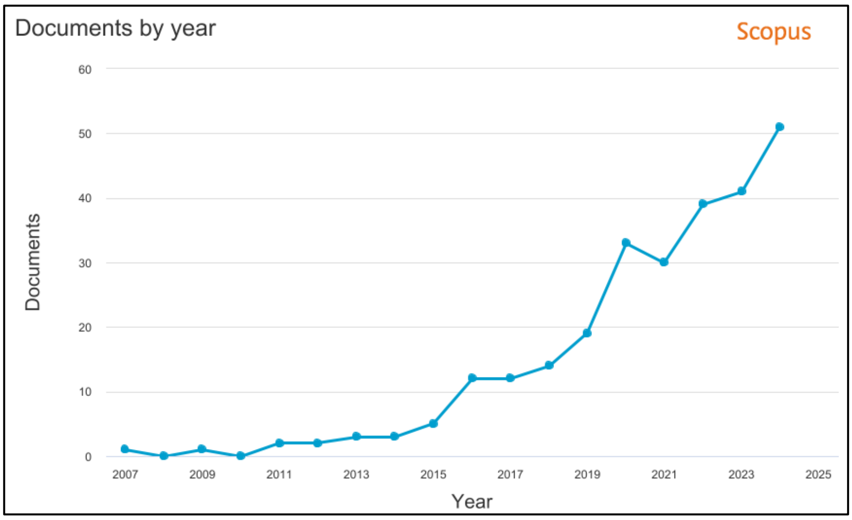

Figure 1. Number of Published Studies on Priming and Stress Memory (2007–2024).

3.2 Number of Documents Published in Different Journals

Figure 2 shows the journals where the documents were published; the majority of them appeared in *Frontiers in Plant Science*, which accounted for a total of 17 publications. Notably, the journal *Plant Cell and Environment* had the highest number of publications in a single year, with 7 articles published in 2019. However, following a peak in publication output across journals in 2022, there has been an irregular trend in the number of publications related to the keywords "stress memory" and "priming" in plants. This trend is particularly evident in the journal *Plant Cell and Environment*, which experienced a sharp decline in the number of related publications after its peak year. This irregularity may reflect shifting research priorities, resource availability, or broader challenges in the scientific community, such as funding shifts. It highlights the need for continued monitoring of publication trends to better understand the dynamics driving research interest in stress memory and priming in plants.

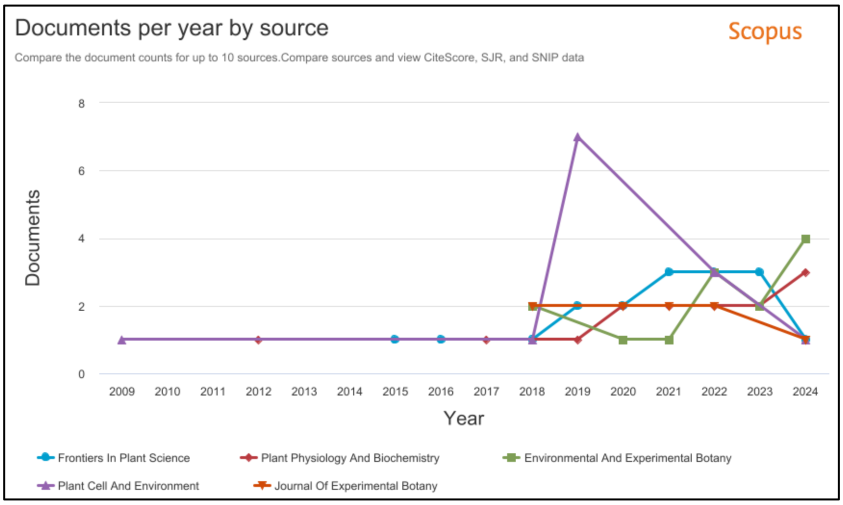

Figure 2. Number of Documents Published in Different Journals.

3.3 Results Based on VOSviewer Computations

Three types of computations were performed using VOSviewer: co-authorship analysis, identification of the most-used keywords, and citation analysis of authors. All 270 selected publications were subjected to this analysis.

3.3.1 Co-authorship Analysis (Authors)

Figure 3 illustrates the co-authorship relationships among authors in the selected publications. The analysis type chosen was "Co-authorship," and the counting method was set to "Full counting." The minimum number of documents per author was set to 1, allowing all 1,083 authors of the publications to meet the threshold. However, only 83 authors were connected through co-authorship, as depicted by the clusters in the figure. The colored bubbles represent authors who have collaborated with others, with the size of the bubbles indicating the number of co-authors each author has had. The four most prominent authors in terms of co-authorship were Isabel Bäurle, Xiangnan Li, Chédly Abdelly, and Margarete Baier.

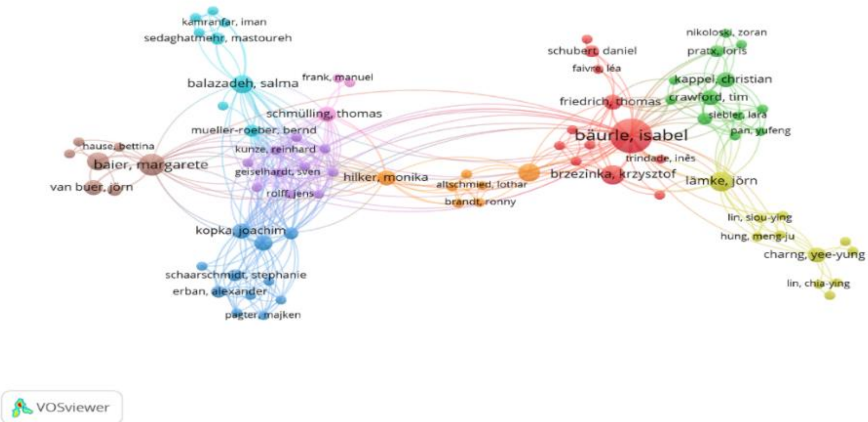

Figure 3. VOSviewer Computations for Authors Network.

3.3.2 Co-authorship Analysis (Organizations)

When the analysis was extended to organizations, 663 organizations met the minimum threshold of one publication. However, only 14 organizations exhibited co-authorship connections, forming a single cluster as shown in Figure 4. Among these, the Institute of Biology in Applied Genetics and Plant Ecology at the Dahlem Centre of Plant Sciences in Germany, as well as the Universität Potsdam, Institute of Biochemistry and Biology, stood out with the highest levels of co-authorship connections. Both organizations are based in Germany, emphasizing the country's central role in collaborative research on stress memory and priming in plants.

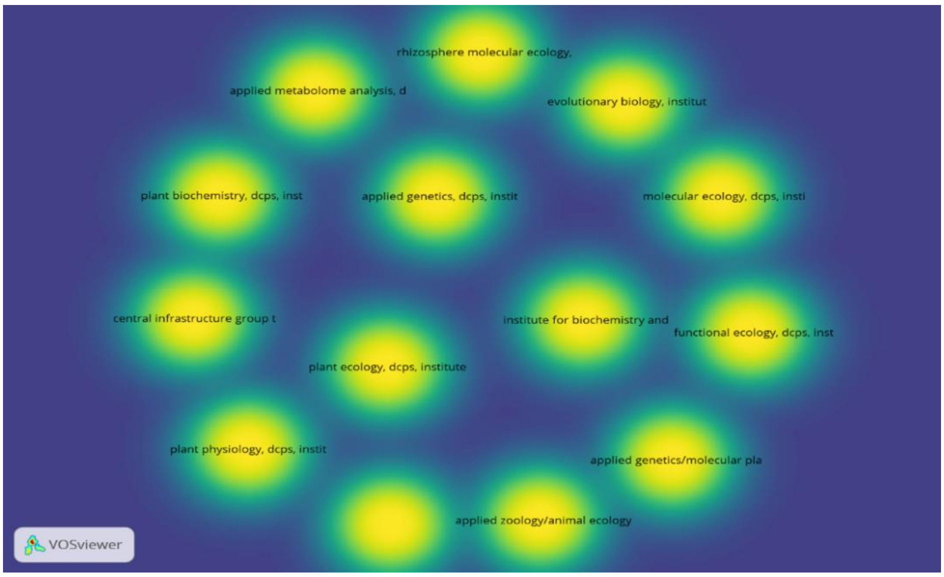

Figure 4. VOSviewer Computations for Organizations Density.

3.3.3 Co-authorship Analysis (Countries).

The co-authorship analysis at the country level revealed that 63 countries met the threshold, but only 54 of them had collaborative links. Germany emerged as the leading country in terms of the number of documents published, while China had the strongest co-authorship connections with other publishing countries. The countries were grouped into 10 clusters, each represented by distinct colors in Figure 5. This clustering highlights the geographical distribution and collaborative networks among countries actively publishing on this topic. The results from these analyses underscore the importance of collaboration at various levels—individual, institutional, and national. Germany's prominent role across all levels suggests its leading position in advancing research on stress memory and priming in plants, supported by robust international partnerships, particularly with China.

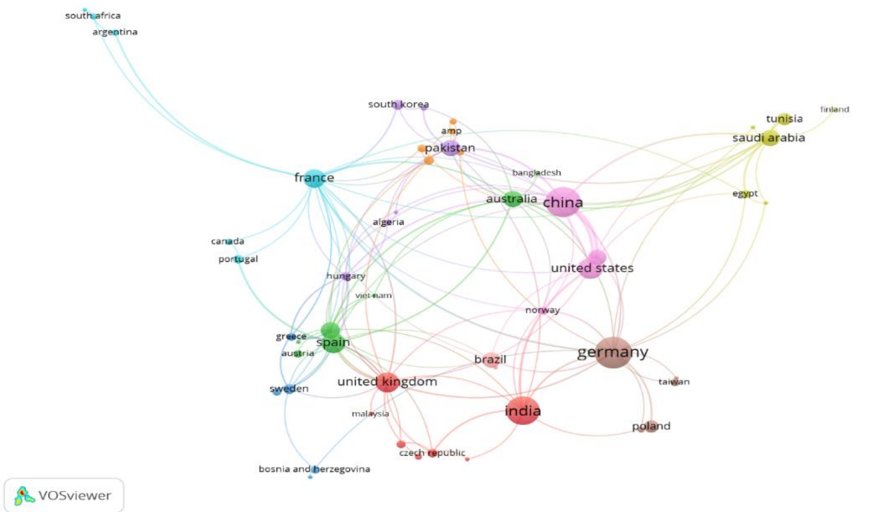

Figure 5. VOSviewer Computations for Countries Network.

The co-occurrence keyword map, displayed in Figure 6, provides valuable insights into the key themes and research trends in the selected publications. The analysis type chosen was "Co-occurrence," with the counting method set to "Full counting." The minimum number of occurrences of a keyword was set to 1, resulting in a total of 1,766 keywords identified from the dataset.

3.3.4 Keywords with the Highest Frequency of Occurrences

Table 1 highlights the keywords with the highest frequency of occurrences. A closer examination reveals that "priming" is the most frequently used keyword in the database. This prominence can be attributed to the substantial number of review articles discussing the priming of plants as a mechanism to develop stress memory. Priming has become a central concept in this field due to its relevance in enhancing plant resilience to abiotic and biotic stresses, as shown in Figure 6. In addition to "priming," several studies focus on genetics, aiming to understand how plants develop stress memory at the cellular and molecular levels. These studies often investigate key processes such as epigenetic modifications, transcriptional regulation, and gene expression patterns that contribute to a plant's ability to "remember" and respond more effectively to recurring stresses. Another significant theme identified through keyword analysis is "metabolism." Research in this area focuses on observing how priming and stress exposure influence plant metabolic pathways, ultimately affecting growth responses and stress adaptation. Studies on metabolism provide critical insights into how energy and resources are allocated during stress responses, shedding light on physiological trade-offs and adaptive mechanisms in plants. Overall, the co-occurrence keyword analysis underscores the multidisciplinary nature of research on stress memory in plants, spanning fields such as plant physiology, molecular biology, and agricultural science. It also highlights the evolving focus on integrating genetic and metabolic insights to develop practical applications for improving crop resilience in the face of climate change and other environmental challenges.

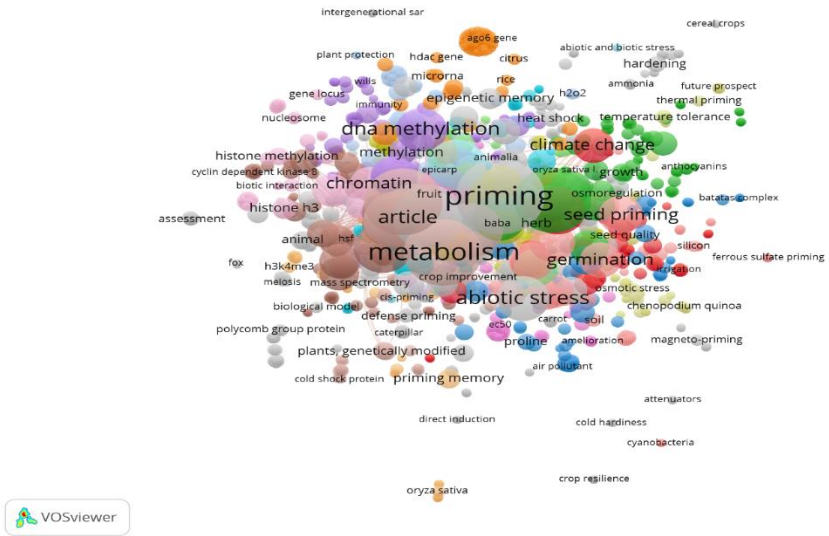

Figure 6. VOSviewer Computations for Keywords Cluster.

Table 1. The ranking of the most frequently occurring keywords for terms “priming”, “stress memory”, and “plants”.

Ranking	Keyword	Occurrence
1	Priming	89
2	Genetics	69
3	Metabolism	69
4	Stress Memory	66
5	Physiological Stress	54
6	Physiology	46
7	Gene Expression Regulation	46
8	Epigenetics	38
9	Arabidopsis	38
10	Drought	35
11	Nonhuman	33
12	Memory	32
13	Abiotic Stress	31
14	Plants	30
15	DNA Methylation	29

3.3.5 Highlighted Keyword Clusters

The keyword map in Figure 7 highlights the interconnected research themes within the realm of plant priming, stress memory, and associated physiological and molecular responses. The central bubble for "priming" is prominently linked to critical terms such as "epigenetics," "DNA methylation," "metabolism," and "abiotic stress," indicating the focal areas of research in this domain. These connections reveal an emphasis on understanding how plants utilize priming mechanisms to enhance resilience to abiotic stresses like drought, heat, and salinity through modifications in epigenetic memory and metabolic pathways. The size and density of these keywords underscore their prominence in the literature, suggesting they are pivotal in the context of plant stress tolerance and adaptive strategies. The clustering of related terms, such as "genetic priming," "defense priming," and "priming memory," emphasizes the multifaceted roles of priming in improving plant performance under environmental challenges. Additionally, keywords such as "climate change," "abiotic stress resistance," and "temperature tolerance" highlight the broader implications of plant priming research in addressing global agricultural challenges. The association with terms like "heat shock," "hardening," and "proline" points to the metabolic and physiological adjustments plants undergo during priming events. The exploration of priming in crops such as *Oryza sativa* (rice) and its potential in enhancing crop resilience demonstrates the application-oriented focus of current research. This map not only reflects the diversity of priming research but also indicates its potential role in developing sustainable agricultural practices to mitigate climate-related stress impacts on crops.

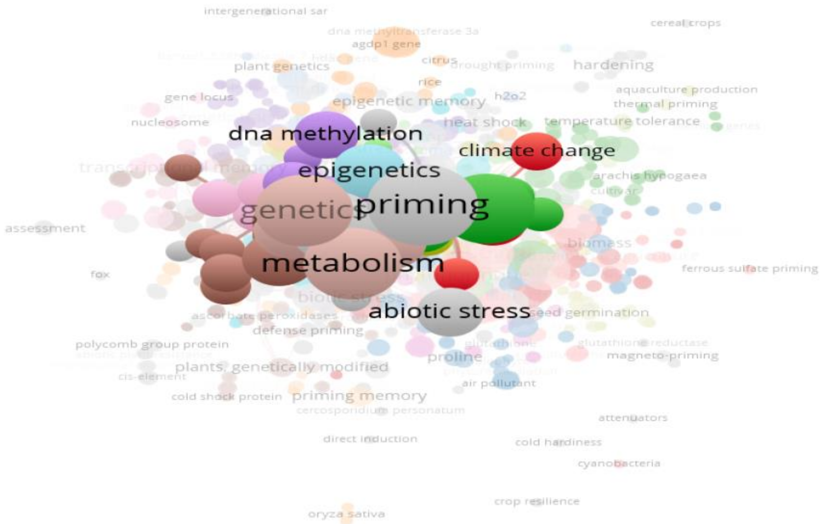

Figure 7. VOSviewer Computations for Keywords Cluster Zoomed in Priming Bubble.

3.3.6 Evolution of Keyword Clusters

Figure 8 illustrates the evolution of research trends in the fields of priming, stress memory, and plant science, as captured through keyword analysis spanning the years 2016 to 2024. The visualization highlights the centrality of key concepts such as "priming," "metabolism," and "abiotic stress," which appear prominently in the figure, signifying their foundational role in this area of study. These keywords dominate the network, reflecting the consistent interest and importance of these topics in understanding plant resilience and adaptive responses. A notable trend in the figure is the emergence of newer, lighter-colored keywords such as "seed priming," "epigenetic memory," and "climate change." These terms indicate a growing focus on applied and contemporary research themes. For example, the emphasis on "seed priming" aligns with agricultural efforts to enhance crop germination and yield under stress conditions, while "epigenetic memory" points to advances in understanding how plants retain and transmit stress adaptations across generations. Similarly, the inclusion of "climate change" highlights the increasing relevance of this research in addressing global environmental challenges. The clustering of terms like "DNA methylation," "histone methylation," and "chromatin" suggests a deeper integration of molecular and epigenetic approaches in studying plant stress responses. These advancements reflect the adoption of cutting-edge technologies and methodologies to explore the underlying mechanisms of priming and stress memory at a genetic and epigenetic level. Additionally, terms such as "osmotic stress," "germination," and "crop resilience" illustrate the practical applications of this research, particularly in improving plant performance under adverse environmental conditions. The appearance of keywords like "magneto-priming" and " prospect" in the periphery suggests emerging areas of exploration and innovation within the field.

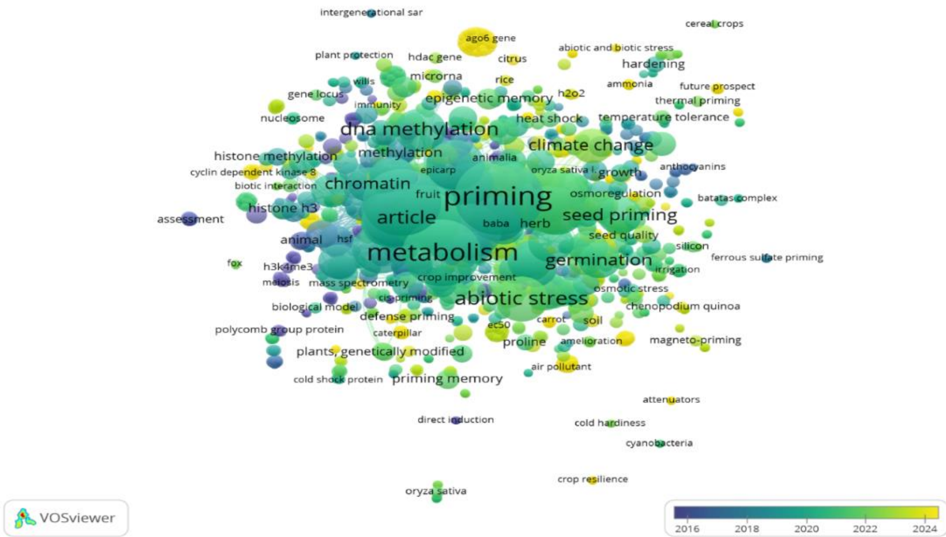

Figure 8. VOSviewer Computations for Evolution of Keyword Clusters.

3.3.6 Bibliometric Analysis

To achieve the fourth objective of this study, a focused bibliometric investigation was conducted. A subset of studies was carefully selected for detailed analysis, ensuring they addressed the core terms relevant to the research: "priming," "stress memory," and "plants." This targeted approach provided a clearer understanding of the trends, themes, and influential works within this niche area of plant science research. From the comprehensive search results, 10 studies were identified as highly relevant for the bibliometric study. These studies were selected based on their significant contributions to the understanding of the interplay between priming, stress memory, and plant responses. Table 2 presents the bibliometric analysis for the selected studies, offering insights into their publication details, citation metrics, and thematic focus. The studies analyzed in this subset highlight the growing interest in exploring how plants can "remember" stress through molecular, physiological, and epigenetic mechanisms. Priming, as a process that prepares plants to respond more effectively to future stresses, emerges as a pivotal concept, particularly in its application to developing climate-resilient crops. The selected studies reflect diverse approaches to investigating this phenomenon, ranging from laboratory experiments focused on molecular pathways to field trials assessing practical applications in agriculture. The bibliometric data also reveal key trends, such as the collaboration patterns among researchers, preferred journals for publishing on this topic, and shifts in research focus over time. These findings underscore the multidisciplinary nature of this research area, drawing from plant physiology, genetics, and agricultural science to address both fundamental questions and applied challenges. By narrowing the focus to these 10 key studies, this bibliometric analysis provides a deeper understanding of the current state of research on priming, stress memory, and plants, as well as identifying potential gaps and opportunities for future investigations.

Table 2. Table of bibliometric analysis regarding the terms "priming", "stress memory", and "plants".

Bibliographic of Selected Studies		f	%
Authors (N=1,083)	Bäurle, I	15	1.39
	Li, X	7	0.65
	Abdelly, C	6	0.55
	Others	1,055	97.41
Subject Area (N=456)	Agricultural and Biological Sciences	219	48.03
	Biochemistry, Genetics, and Molecular Biology	129	28.29
	Environmental Sciences	35	7.67
	Others	73	16.01
Document Type (N=270)	Article	170	62.96
	Review	69	25.56
	Book Chapter	28	10.37
	Others	3	1.11
Source Title (N=270)	Frontiers in Plant Science	17	6.30
	Plant Physiology and Biochemistry	14	5.19
	Environmental and Experimental Biology	13	4.81
	Plant Cell and Environment	13	4.81
	Others	213	78.89
Publication Stage (N=270)	Final	265	98.15
	Article in Press	5	1.85
Keyword (N=1,766)	Priming	89	5.04
	Genetics	69	3.91
	Metabolism	69	3.91
	Stress Memory	66	3.74
	Others	1,473	83.40
Affiliation (N=663)	Universität Potsdam	17	2.56
	Chinese Academy of Sciences	13	1.96
	Freie Universität Berlin	12	1.81
	Others	621	93.67
Country (N=408)	Germany	49	12.01
	China	43	10.54
	India	39	9.56
	Others	277	67.89
Language (N=270)	English	264	97.78
	Chinese	5	1.85
	Russian	1	0.37
Open Access (N=344)	All Open Access	149	43.31
	Gold	80	23.26
	Green	64	18.60
	Bronze	27	7.85
	Hybrid Gold	24	6.98

As shown in Table 2, the bibliometric analysis provides a comprehensive overview of research output on "priming," "stress memory," and "plants" during the time period from 2007 to 2024. Among the 270 analyzed studies, Bäurle emerged as the most prolific author, contributing 15 documents or 1.39% of the total publications, demonstrating their significant involvement and expertise in this field, as exposed in Figure 9. The subject area with the highest representation is Agricultural and Biological Sciences, accounting for 48.03% of the total studies as reflected in Figure 10. This dominance reflects the core focus of these terms on understanding plant responses and adaptations in agricultural and ecological contexts. In terms of document type, research articles constitute the majority, comprising 62.96% of the total as revealed in Figure 11. This indicates that the field is predominantly driven by empirical investigations and experimental studies, which form the foundation for theoretical and applied advancements. Among journals, *Frontiers in Plant Science* published the most articles, contributing 6.30% of the total output, further highlighting its prominence as a platform for disseminating research on plant science. The vast majority of the documents, 98.15%, are in their final publication stage, signifying that most studies have undergone peer review and formal publication processes. Keywords analysis reveals that "priming" is the most frequently used term, appearing in 5.04% of the studies, underscoring its central role in this research domain. Institutional analysis shows that Universität Potsdam is the leading institution, contributing 2.56% of the total publications, as mirrored in Figure 12. At the country level, Germany leads with 12.01% of the total documents, reflecting its strong research output and collaboration in this area, as shown in Figure 13. The linguistic analysis indicates that the vast majority of publications are written in English (97.78%), emphasizing the global nature of this research field and the predominance of English as the lingua franca of scientific communication. Furthermore, 43.31% of the documents are open access, facilitating broader dissemination and accessibility of research findings to the global scientific community.

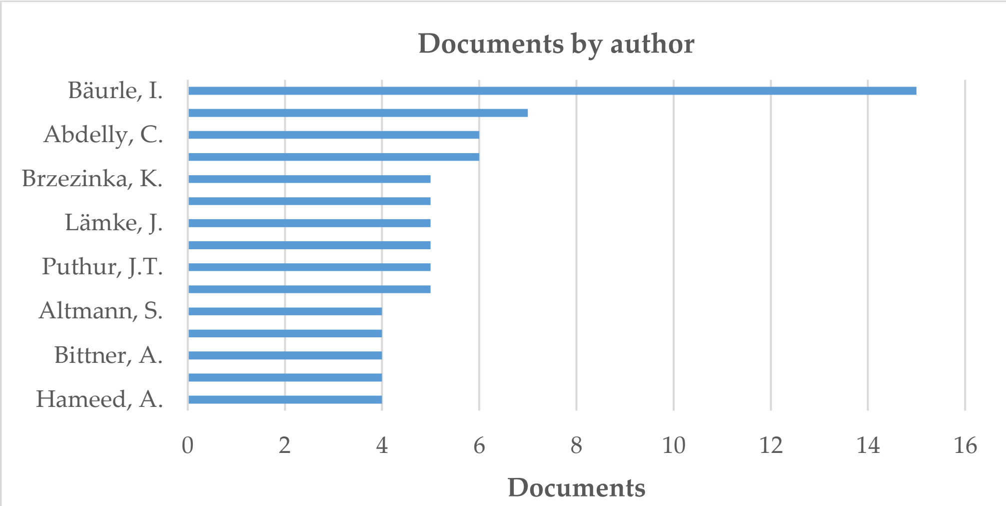

Figure 9. Ratio of Documents by Authors.

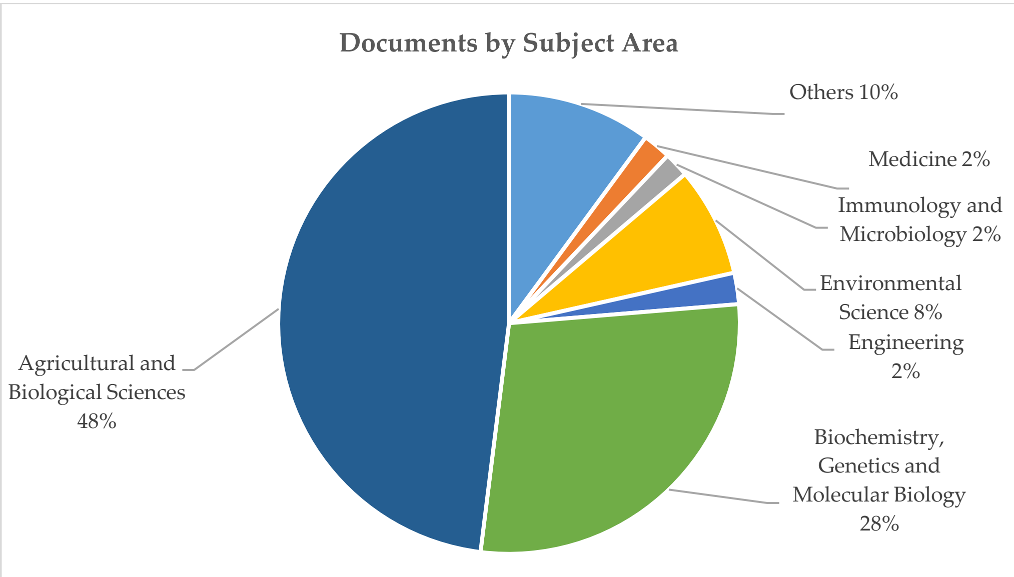

Figure 10. Ratio of Documents by Subject Area.

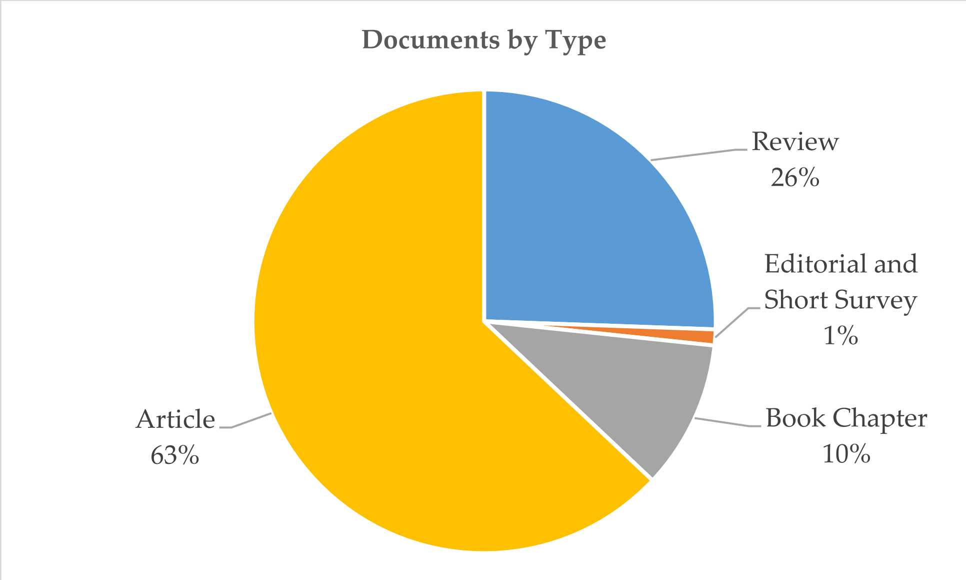

Figure 11. Ratio of Documents by Type.

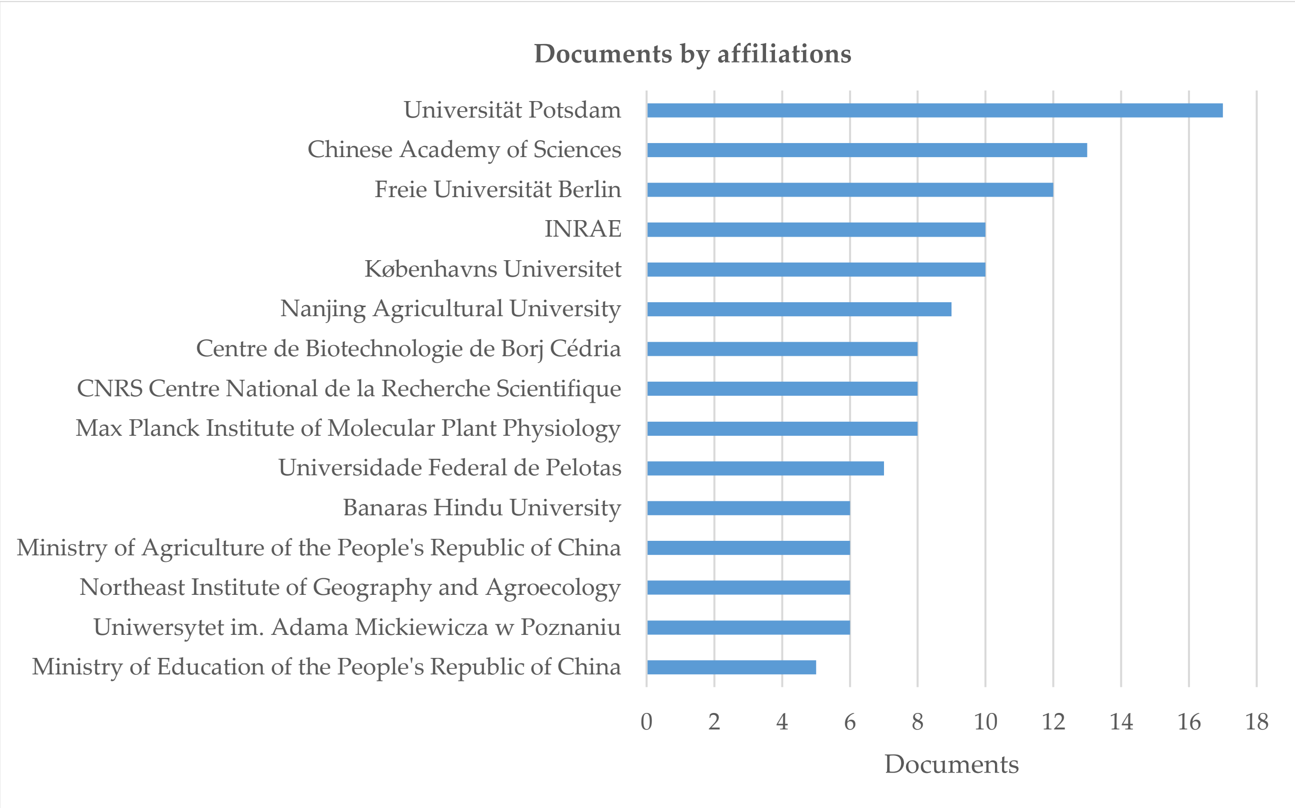

Figure 12. Ratio of Documents by Affiliations.

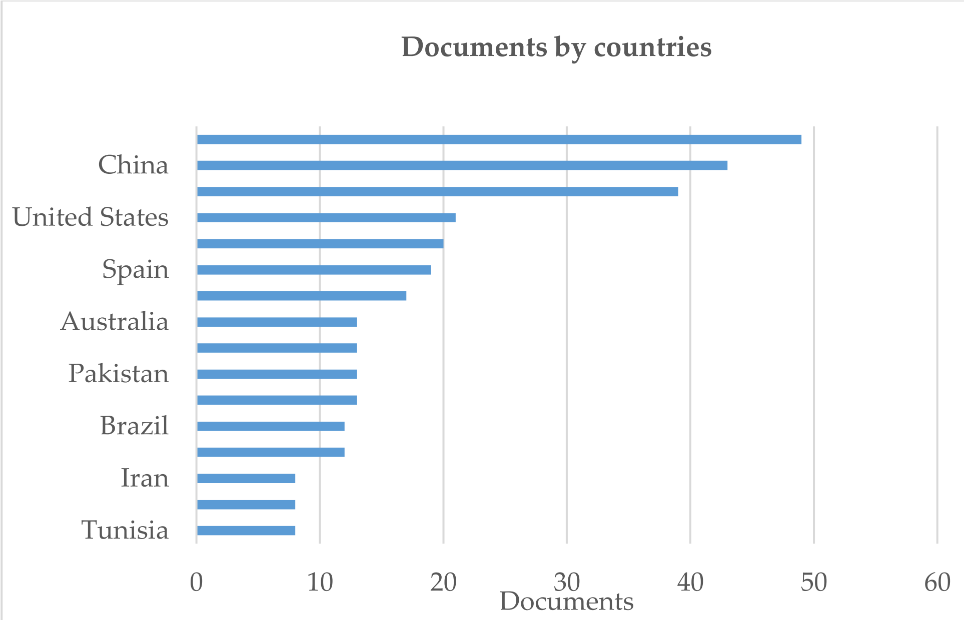

Figure 13. Ratio of Documents by Affiliations.

4. Conclusions

The results of our bibliometric analysis provide a detailed snapshot of the research trends surrounding stress memory and priming in plants, crops, and vegetation. The clustering of keywords reveals the diversity of themes explored within this field, including stress memory mechanisms, epigenetic modifications, transcriptional regulation, metabolic changes, and the practical applications of priming for enhancing crop resilience. The prominence of the keyword "priming" highlights its central role in current research, emphasizing its importance in understanding how plants respond to stress and how these responses can be leveraged to improve agricultural practices. Our analysis also reflects the collaborative nature of this research, with significant international partnerships, particularly between Germany and China, driving much of the output. Interestingly, while the majority of the studies are published in Agricultural and Biological Sciences, there is a notable focus on the practical applications of these findings, aiming to improve crop performance and environmental resilience. When analyzing the bibliometric data, it is evident that most studies are in the final publication stage, and a large proportion of them are openly accessible, promoting broader dissemination of knowledge. Similar to other emerging fields, there is a notable emphasis on research articles, which account for the bulk of the documents analyzed. Overall, this growing body of work signifies the increasing importance of stress memory and priming in plants as a key area of inquiry for advancing agricultural sustainability and resilience.

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