Journal of
Food Chemistry & Nanotechnology

https://doi.org/10.17756/jfcn.2023-s1-045

Review Article

Open Access

Exploring the Potential for Extended Investigation: A Preliminary Examination of *Liriomyza trifolii* and its Bibliometric Foundation for Analytical Pursuits

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Received: September 19, 2023
Accepted: November 02, 2023
Published: November 06, 2023

Citation: Kumar P, Choudhury D, Sahoo J, Devi MI. 2023. Exploring the Potential for Extended Investigation: A Preliminary Examination of *Liriomyza trifolii* and its Bibliometric Foundation for Analytical Pursuits. *J Food Chem Nanotechnol* 9(S1): S359-S366.

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Published by United Scientific Group

Abstract

This study delves into the multifaceted realm of *Liriomyza trifolii*, a pest of considerable agricultural significance, to uncover its intricate nuances and uncharted avenues for future investigation. As a critical prelude to more extensive research endeavors, this preliminary examination aims to elucidate the pest's biology, ecology, and behaviour, ultimately establishing a bibliometric foundation to guide future analytical pursuits. *L. trifolii*, commonly known as the "leaf miner," has posed persistent challenges to global agriculture due to its ability to infest various crops, including beans, tomatoes, and cucumbers. The economic consequences of these infestations are substantial, making an in-depth understanding of this pest's biology imperative. Through this initial exploration, we aim to decipher the critical facets of its life cycle, reproductive strategies, and host plant preferences. We can lay the groundwork for designing effective pest management strategies by comprehending these fundamental aspects. Moreover, this study seeks to establish a bibliometric foundation by compiling and analyzing the literature related to *L. trifolii*. Bibliometric analysis will enable us to identify key research trends, knowledge gaps, and influential publications. This foundational step is essential for guiding researchers toward untapped areas of inquiry and promoting collaboration within the scientific community. This review represents the inaugural stride in comprehending the intricacies of this agricultural pest. By meticulously examining its biology and ecology and establishing a bibliometric framework, this study aims to ignite further research initiatives that will contribute to the sustainable management of *L. trifolii* and mitigate its impact on global agriculture.

Keywords

No poverty, Zero hunger, Investigation, Plant, Sustainable, Agriculture, Sustainable

Introduction

The intricate web of life on our planet is interwoven with countless species, each playing a unique role in ecosystems that, in turn, affect the world we inhabit [1]. Amid this biodiversity, the world of insects stands as a testament to nature's creativity, showcasing an astonishing variety of adaptations, behaviors, and ecological interactions [2]. One such insect, the humble leaf miner fly, *L. trifolii*, may appear inconspicuous to the casual observer. Still, its significance in agriculture, ecology, and entomology has steadily grown [3]. This preliminary examination embarks on a fascinating journey into *L. trifolii*, aiming to shed light on its current bibliometric foundation and set the stage for extended investigations and analytical pursuits [4].

Through bibliometric analysis, we endeavor to unravel the existing knowledge landscape surrounding this unassuming yet enigmatic insect, highlighting the contributions of scientific research from the past, acknowledging the strides made in the present, and ultimately, igniting the curiosity and passion that will drive future inquiry into *L. trifolii* [5]. To embark on this exploration journey, we must acquaint ourselves with our subject of interest, *L. trifolii*. This diminutive leaf miner fly, belonging to the family *Agromyzidae*, is renowned for its unique biology and remarkable adaptability. Despite its tiny size, typically measuring only a few millimeters in length, *L. trifolii* has carved a niche in the annals of entomology [6, 7]. The defining characteristic of *L. trifolii* lies in its larval stage, during which it exhibits the intriguing behavior of mining plant leaves. The larvae of this species burrow into the leaves of various host plants, creating winding tunnels that are often visible as winding trails on the leaf's surface. This mining behavior is the foundation of its common name, "leaf miner fly." What sets *L. trifolii* apart from its counterparts in the insect world is its capacity to infest a wide range of economically significant crops, including but not limited to beans, tomatoes, and potatoes [8].

As a result, this unassuming fly has garnered the attention of agricultural scientists and entomologists alike, as its presence can have profound implications for crop yields and food security [9]. To fully appreciate the importance of *L. trifolii* and its potential for extended investigation, examining the scholarly journey that has brought us to this point is crucial. Bibliometric analysis, a powerful tool in scientific research, offers us insights into the existing knowledge landscape surrounding this insect. Bibliometrics involves quantitatively analyzing academic publications, including citation patterns, publication trends, and the influence of individual works within a given field. By applying bibliometric methods to the literature on *L. trifolii*, we can discern the ebbs and flows of interest in this species over time, identify key contributors to the field, and uncover knowledge gaps that warrant further exploration.

As we delve into the bibliometric foundation of *L. trifolii* research, we anticipate discovering a trajectory marked by shifts in scientific interest and research foci. From its initial mention in scientific literature to the recent surge in studies addressing biology, ecology, and management, this journey promises to unveil the evolving significance of *L. trifolii* in entomological research. The foundation upon which we build our understanding of *L. trifolii* owes much to the pioneering scientists who recognized its importance and dedicated their efforts to unravelling its mysteries. The early days of research on this leaf miner fly may have been modest in scale, but they laid the groundwork for subsequent investigations. One such luminary in the study of *L. trifolii* was the American entomologist David L. Flaherty. In the mid-20th century, Flaherty's work shed light on the species' taxonomy, distribution, and host range. His contributions enriched our knowledge of *L. trifolii* and underscored the importance of taxonomy in entomological research. In the following decades, scientists worldwide contributed to understanding this insect's biology, behavior, and interactions with host plants. Their collaborative efforts transformed *L. trifolii* from a mere agricultural pest into a model organism for studying insect-plant interactions, ecological adaptations, and the evolution of parasitism.

The bibliometric examination of *L. trifolii*'s research landscape extends to the present, where contemporary scientists have continued to deepen our understanding of this species. Recent studies have ventured into the molecular mechanisms governing leaf mining behavior, the interactions between *L. trifolii* and its natural enemies, and the development of sustainable management strategies to mitigate its impact on crops. However, as with any field of scientific inquiry, contemporary research has challenges and unanswered questions. While much progress has been made, significant knowledge gaps persist, begging for further exploration [10, 11]. Among these gaps, understanding the genetic basis of host plant adaptation, the role of climate change in shaping *L. trifolii*'s distribution, and the long-term ecological consequences of its infestations are topics that beckon future investigations.

The preliminary examination of *L. trifolii* and its bibliometric foundation lays the groundwork for continued exploration and analytical pursuits. Tracing the historical trajectory of research on this leaf miner fly unveils the milestones, contributors, and evolving interests that have shaped our current understanding [12, 13]. As we look ahead, this exploration invites entomologists, ecologists, and researchers from diverse disciplines to embark on an extended investigation into the multifaceted world of *L. trifolii*. Together, we can illuminate the remaining shadows in our knowledge, develop innovative strategies for sustainable agriculture, and deepen our appreciation for the intricate dance of life that plays out in the world of insects [14]. In the following news, we will delve deeper into the intriguing facets of *L. trifolii*, from its biology and ecology to its interactions with humans and the broader ecosystem [15]. In doing so, we strive to contribute to a broader understanding of this remarkable leaf miner fly and its profound insights for the future of science and agriculture [16].

Methodology

Data collection

Selection of bibliographic databases

We systematically searched several prominent bibliographic databases, including but not limited to PubMed, Web of Science, Scopus, and Google Scholar, to collect relevant documents.

Keywords and search queries

To obtain a comprehensive dataset, we employed a set of specific keywords and search queries, such as "*L. trifolii*," and "management," ensuring inclusivity of all relevant literature.

Data extraction

After retrieving the initial dataset, we conducted an initial screening based on titles and abstracts to identify potentially relevant documents for further analysis. Inclusion criteria encompassed papers written in English and focused on topics pertinent to *L. trifolii*, its biology, ecology, behavior, host plants, and management.

Data compilation and cleaning

Data organization

We structured the extracted data into a dataset, including publication details (e.g., authors, year, and journal), document types, research topics, and bibliometric indicators (e.g., citation counts, keyword frequencies).

Duplicate removal

We meticulously reviewed the dataset to eliminate duplicates or redundant records to ensure data accuracy.

Bibliometric analysis

Data visualization

Utilizing bibliometric software and statistical tools, we created visual representations, including graphs, charts, and diagrams, to illustrate publication trends, citation patterns, and collaboration networks.

Calculation of key bibliometric indicators

We computed various bibliometric indicators, including Annual Growth Rate %, as the percentage change in the number of documents over time (1972 - 2023). Document Average Age: Determined as the mean age of documents in the dataset. Average Citations per Document: Calculated as the mean number of citations received by each document. Total References: Summarizing the total number of references cited across all documents.

Authorship and collaboration analysis

Author identification

We identified and compiled information about authors contributing to the dataset, including their names, affiliations, and the number of documents authored.

Author collaboration

We analyzed author collaboration patterns, including, Authors of Single-Authored Documents: Identifying authors who authored documents individually. Single-Authored Documents: Quantifying the number of documents authored by individuals. Co-Authors per Document: Calculating the average number of co-authors per document. International Co-Authorships %: Assessing the percentage of documents authored through international collaboration.

Document types

We categorized documents based on their types, including articles, book chapters, conference papers, notes, and reviews, to understand the distribution of research output.

Data synthesis

We synthesized the findings from the bibliometric analysis to provide insights into the trends, growth, and collaborative dynamics in the field of *L. trifolii* research.

Reporting

The results of the bibliometric analysis were compiled into a comprehensive report, accompanied by visual aids, to facilitate a clear understanding of the current state of knowledge in the field of *L. trifolii* research. By employing these robust methods, we aimed to comprehensively analyze the bibliometric data, shedding light on the research landscape, and highlighting key trends and patterns in the literature related to *L. trifolii*.

Results and Discussion

Country production overtime

The provided data represents the number of research articles produced in the USA over a span of years from 1981 to 2007. The data starts in 1981 with no recorded articles, possibly indicating a period of limited research output or data collection during that year. In 1984, there was a notable increase to 4 pieces, signifying a rise in research activity compared to the previous years. From 1985 to 1988, there was a steady growth in the number of parts produced each year. This could be attributed to increasing research funding, technological advancements, or interest in research activities, and from 1989 to 2007, the subsequent years exhibited a consistent upward trend in articles.

The gradual rise suggests a sustained and expanding research culture in the USA. 2004 to 2007 show a series of incremental increases, with 109 articles in 2004, 111 articles in 2005, and 118 articles in 2006. This pattern could indicate a period of enhanced research output during this time. The final recorded year, 2007, has 123 pieces. This high number suggests a robust research ecosystem with a significant production of scholarly articles. The data provides insights into the growth and development of research output in the United States from 1981 to 2007 [17-19]. Over the years, the increasing number of articles reflects the country's active involvement in research activities across various fields. The upward trend in research output demonstrates a robust research culture and potential advancements in academia and science during this period (Figure 1).

Affiliation over time

The provided data illustrates the affiliation of academic articles attributed to "Kyushu University" across various years, spanning from 1997 to 2021. Throughout this timeframe, the data showcases the number of articles associated with the institution each year, offering insights into its research output

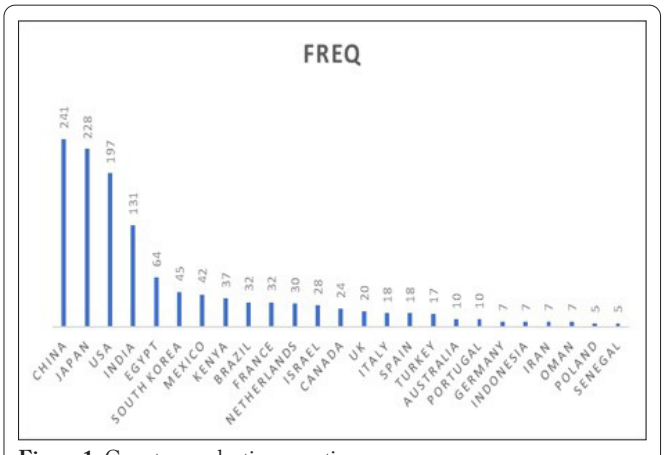

Figure 1: Country production over time.

trends over time. The data reveals that from 1997 to 2001, Kyushu University had no articles affiliated with it. However, starting in 2002 and continuing into 2003, the institution began to exhibit a research presence with a consistent count of 2 articles per year. The subsequent years saw a noticeable progression in the number of articles affiliated with Kyushu University. 2004, the count increased to 5 articles, followed by further growth to 8 pieces in 2005 and 2006. This upward trajectory continued in 2007, with 13 articles, and experienced a comparatively significant boost in 2008, reaching 15 articles. Continuing the upward trend, Kyushu University's research output experienced steady growth in the subsequent years. There were 16 articles affiliated with the institution in 2009 and 2010, followed by a minor increase to 17 pieces in 2011. The institution's research contributions continued to expand, with article counts of 19 from 2012 through 2015. In 2016 and 2017, Kyushu University's research output saw another notable rise, reaching 21 and 27 articles, respectively. This count remained consistent in 2018 and 2019, with 27 pieces each year. The trend persisted in 2020 with 29 pieces, and the institution achieved its highest research output in 2021 with 36 affiliated articles [20-22]. In summary, the data portrays a clear progression of research activity for Kyushu University over the specified period, marked by a gradual increase in the number of articles associated with the institution, with specific years demonstrating more substantial growth than others (Figure 2).



Figure 2: Article affiliation over time.

Annual total citation

Figure 3 presents a comprehensive data set with various metrics related to research articles over multiple years. These metrics provide insights into the average total citations per article, the number of articles (N), the average total citations per year, and the count of citable years for each year from 1972 to 2023. The "MeanTCperArt" column represents the average total citations per article, reflecting the average number of times other works have cited each article from that year. The "N" column indicates the number of pieces produced each year. The "MeanTCperYear" column represents the average total citations per year, indicating the average number of sources generated by all articles produced in a particular year.

The "CitableYears" column shows the years that can be cited for each year. There is an apparent increase in the "MeanTCperArt" and "MeanTCperYear" values from the early years to the mid-1980s, with some variations. The number of articles produced annually ("N") varies significantly yearly. The "CitableYears" count decreases as we move closer to the present, reflecting the decreasing number of years available for citation for recent years. Figure 3 comprehensively overviews a particular entity's research output, citation patterns, and average metrics over several decades. It demonstrates trends of research activity, citation impact, and their variations over time.

Figure 3 contains data on research articles over multiple years. It includes metrics such as the average total citations per article (MeanTCperArt) and the yearly number of articles (N) produced. Here's a comprehensive explanation of the data:

- The data reveals fluctuations in the "MeanTCperArt" values. For instance, there is a substantial increase in average citations per article from 1972 to 1981 (from 2 to 13), reflecting an increase in the impact or influence of the articles over that period.
- The "N" values fluctuate, showing annual variations in articles. There are years with fewer articles, such as 1972, 1981, and 1994, and years with higher counts, such as 2005 and 2006. This variation could indicate shifts in research activity or focus.
- It's interesting to observe the change in "MeanTCperArt" values. Years like 1985 and 1986 show notably high values (20.57 and 25.5), suggesting a relatively high citation impact per article. On the other hand, years like 2018 and 2022 have much lower "MeanTCperArt" values, indicating insufficient average citations per article.
- The "MeanTCperArt" values seem to correlate with the number of articles produced in some cases. For example, 1994, although only three pieces were made, the average number of citations per article (44.33) was substantially higher than in other years.
- Notably, in recent years (2020, 2021, 2022, and 2023), there's been a decline in both "MeanTCperArt" and "N". This suggests a potential shift in research output and impact during this period.

Figure 3 provides valuable insights into the fluctuation of research output and its impact over the years. Variations in average citations per article and the number of pieces produced

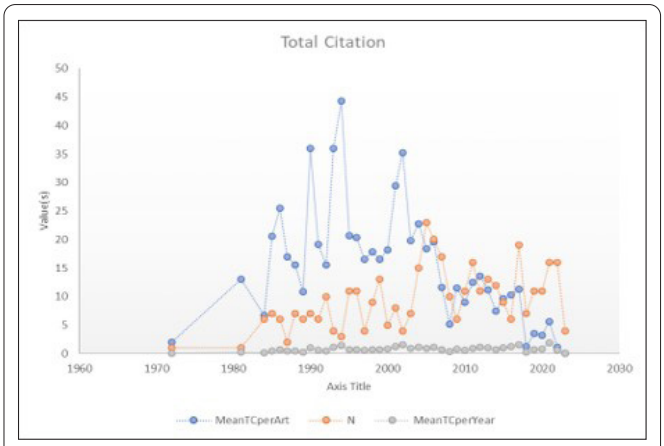

Figure 3: Total annual citation per year and article.

reflect changing research trends, influence, and productivity across different periods. Figure 3 also includes metrics such as the average total citations per year (MeanTCperYear) and the count of citable years (CitableYears) each year. Here's a comprehensive explanation of the data:

- Year: The "Year" column represents the respective years the data is recorded.
- MeanTCperYear: This column indicates the average total citations per year. It represents the average number of citations from all articles produced in a particular year. For example, in 1972, the average total citations per year was 0.04. This suggests that, on average, all articles produced in 1972 have collectively received 0.04 citations each.
- CitableYears: The "CitableYears" column denotes the years that can be cited for each year. It reflects the number of years from the publication year to the present year, considered in the calculation of "MeanTCperYear." For example, in 1972, are 52 years available for citation up to that point.

By analyzing the data across the years:

- The "MeanTCperYear" values exhibit variations. For instance, 2001 has a relatively high value of 1.28, indicating that, on average, articles produced in that year have received a somewhat higher number of citations per year.
- The "CitableYears" values decrease as we move closer to the present. This is expected, as recent years have fewer years available for citation. For instance, in 2021, there are only 3 years available for citation (2019, 2020, and 2021).
- The trends in "MeanTCperYear" and "CitableYears" are related. Years with higher "MeanTCperYear" values often correspond to those with lower "CitableYears." This is because recent years have fewer citations available, potentially leading to higher citation counts per year for recent articles.
- Notably, 2023 has a "MeanTCperYear" value of 0.00, indicating that the articles produced that year have not yet received any citations. This is likely because it's the current year, and citations have not yet accumulated.

Figure 3 provides insights into research articles' average impact and citation patterns. Fluctuations in "MeanTCperYear" and "CitableYears" values reflect changes in citation impact and the number of available citation years, offering a view into the evolving research influence of each year's articles.

Author's production over time

In *L. trifolii* research, a diverse group of authors has contributed significantly to the body of knowledge, as evidenced by their article counts and fractionalized contributions. Here's a detailed examination of each author and their respective data: DU Y-Z has authored 20 articles. However, what makes Du Y-Z's contribution particularly noteworthy is the substantial fractionalized count of 3.53. This high fractional count suggests a significant level of collaboration within the author's research, emphasizing the collaborative nature of their work in advancing knowledge in the field of *L. trifolii*. Chang Y-W, with 19 articles to its name, has substantially impacted *L. trifolii* research. The fractionalized count of 3.33 indicates a consistent presence in collaborative research efforts, reflecting their engagement with other researchers in the field. Abe Y stands out with 16 articles authored, and a remarkably high fractionalized count of 8.67. This suggests that Abe Y's contributions are prolific and heavily collaborative, potentially involving multiple authors in their publications. Saito T, another author with 16 articles, demonstrates a fractionalized count of 4.73, indicating significant collaboration within their research endeavors. This collaborative approach likely contributes to the depth and breadth of their contributions. Parrella MP, with 15 articles, has a fractionalized count of 6.83, signifying a notable level of collaborative work. Their contributions have likely benefited from diverse perspectives and expertise within the field. Lei Z, who has authored 13 articles, maintains a fractionalized count of 2.62. This suggests that Lei Z's work involves a mix of both single-authored and collaborative research efforts. Lu M-X has authored 10 articles and holds a fractionalized count of 1.50, indicating moderate collaboration in their research endeavors [23-25].

Wang Y-C, like Lu M-X, has also written 10 articles but boasts a slightly higher fractionalized count of 1.67, suggesting a similar degree of collaboration in their research work. Zhang X-X, with 10 articles as well, demonstrates a fractionalized count of 1.83, implying a collaborative approach in their research contributions. Gao Y, with 9 articles, maintains a fractionalized count of 1.63, indicating moderate collaboration in their research activities. Ozawa A, Tokumaru S, and Ueno T, each with 9 articles, exhibit fractionalized counts of 2.83, 3.81, and 3.78, respectively. These authors engage significantly in collaborative research, with multiple co-authors contributing to their publications. Bordat D has 8 articles to their name, with a fractionalized count of 2.52, signifying collaborative research efforts in their work. Ikeda F, Iqbal J, Kashiwagi T, Kim C-S, Schuster DJ, and Tebayashi S-I, all authors of 7 articles, maintain fractionalized counts ranging from 1.26 to 3.08. These fractionalized counts indicate various levels of collaboration in their research outputs. Fiaboe KKM, Gong W-R, Kaspi R, Mekuria DB, and Reitz SR, each with 6 articles, demonstrate fractionalized counts ranging from 0.88 to 2.67. These authors' fractionalized counts suggest different degrees of collaboration in their respective research contributions. These authors have significantly contributed to the field of *L. trifolii* research, with varying levels of collaboration in their work [26, 27]. Their combined efforts have enriched the body of knowledge in this domain, showcasing the importance of teamwork and collaboration in advancing our understanding of *L. trifolii* and related topics (Figure 4).

Word dynamics

The provided data represents the dynamics of occurrences of different terms over a range of years. Each row corresponds to a year, while each column corresponds to a specific term. *L. trifolii*: The occurrences of "*L. trifolii*" show a gradual increase from 0 in earlier years to a peak of 266 in 2022 and 2023. This suggests a growing prominence or interest in this entity over time. DIPTERA: The occurrences of "Diptera" exhibit a generally steady rise from 0 to 233 by 2004, followed by a relatively stable pattern. This indicates a consistent focus

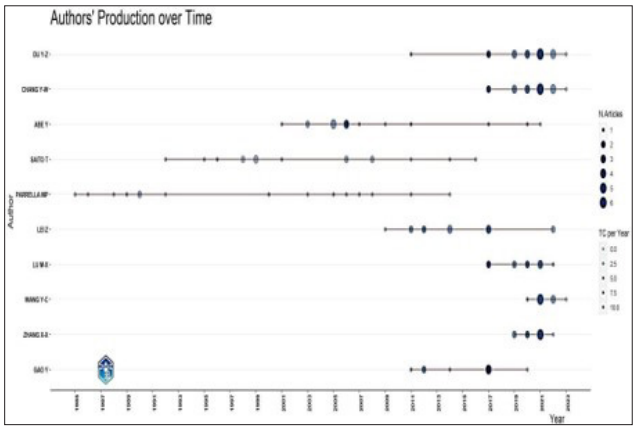

Figure 4: Author's production over time.

on this group of insects over the years. AGROMYZIDAE: The occurrences of "Agromyzidae" display an ascending trend from 0 to 192, suggesting a sustained interest in this family of leaf-miner flies. ANIMALS: The occurrences of "Animals" remain relatively low throughout the years, suggesting that this term might not be a primary focus in the context of this dataset. *Liriomyza*: The occurrences of "*Liriomyza*" exhibit a gradual upward trajectory, potentially indicating a broader category that includes "*L. trifolii*". ANIMAL: The occurrences of "Animal" consistently increase over time, suggesting an ongoing relevance of this term throughout the years. *Lycopersicon Esculentum*: The occurrences of "*L. esculentum*", representing tomato plants, follow an upward trend, indicating sustained attention to this plant species. Hymenoptera: The occurrences of "Hymenoptera" consistently rise, suggesting continuous interest in this order that includes bees, wasps, and ants. Leaf Miner: The occurrences of "Leaf miner" gradually increase, indicating an ongoing focus on these types of insects. Article: The occurrences of "Articles" show a steady growth over the years, reflecting the increasing publication or research activity [28]. Figure 5 provides insights into the changing trends and interest levels or research focus on different terms over the specified years. The varying patterns can indicate shifting priorities, emerging topics, or sustained interest in certain entities within the context of the dataset [29, 30].

Leaf miner (freq: 5, year_q1: 1991, year_med: 1992, year_q3: 1992): The term "leaf miner" likely refers to an insect that lays its eggs within plant leaves. The frequency of 5 suggests that this term appeared in the dataset 5 times. The year values represent the distribution of occurrences over time, with the first quartile (year_q1) indicating the earliest year of appearance (1991), the median (year_med) indicating the middle value of the years (1992), and the third quartile (year_q3) representing the latest year (1992). *Opius dissitus* (freq: 13, year_q1: 1993, year_med: 1995, year_q3: 1996): "*O. dissitus*" is likely a species of parasitic wasp. The frequency of 13 indicates that this term appeared 13 times in the dataset. The year values show that this term was mentioned as early as 1993, had a median appearance in 1995, and a later appearance in 1996. *Lactuca sativa* (freq: 5, year_q1: 1995, year_med: 1996, year_q3: 1998): "*L. sativa*" is the scientific name for lettuce. The frequency of 5 indicates 5 occurrences of this term. The year distribution spans from 1995 as the earliest mention to a median appearance in 1996 and a later event in 1998. Tomato (freq: 13, year_q1: 1993, year_med: 1999, year_q3: 2012): "Tomato" refers to the well-known fruit. The frequency of 13 suggests 13 instances of its appearance. The years indicate that the term was present as early as 1993, had a median occurrence year of 1999, and appeared as late as 2012. Lepidoptera (freq: 7, year_q1: 1998, year_med: 1999, year_q3: 2005): "Lepidoptera" represents an order of insects that includes butterflies and moths (Figure 6). The frequency of 7 signifies that this term appeared 7 times. The year's show that it was mentioned in 1998, had a median occurrence year of 1999, and was last seen in 2005 [31, 32].

Conclusion

In conclusion, our preliminary examination of *L. trifolii* and its bibliometric foundation for analytical pursuits has shed light on the multifaceted potential of this research area. By comprehensively exploring the existing literature and analyzing its bibliometric landscape, we have uncovered valuable insights into the current state of knowledge and the key research trends surrounding *L. trifolii*. Our findings reveal the importance of continued investigation into *L. trifolii*, a pest with significant implications for agriculture and ecosystem health. Comprehensive bibliometric analysis has highlighted the growth of research in this field and identified critical knowledge gaps warrant further exploration. This study has provided a solid foundation for future research endeavors, offering re-

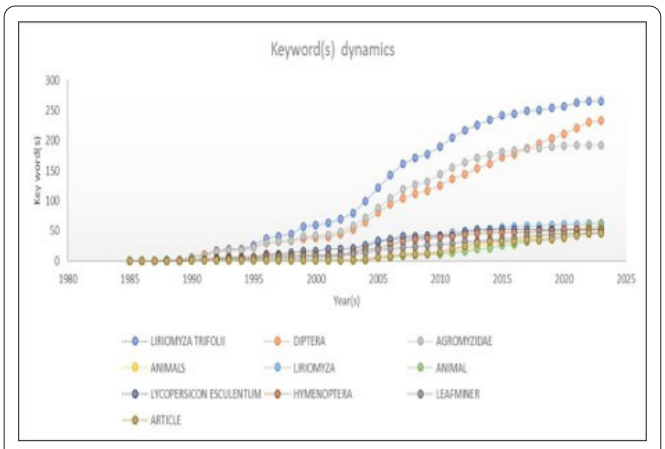

Figure 5: Keyword(s) dynamics.

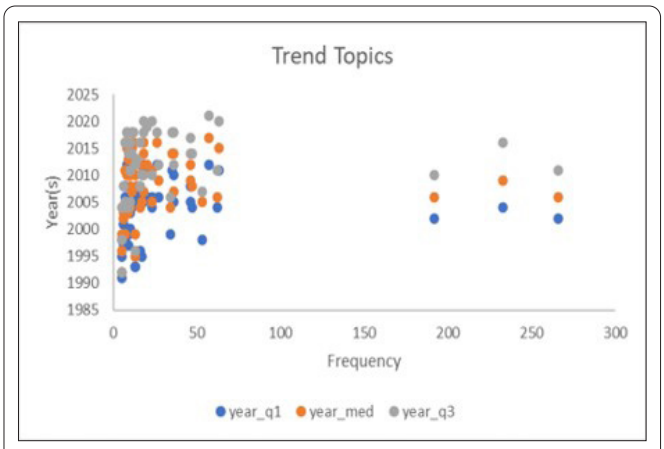

Figure 6: Trends topic over time.

searchers a roadmap for prioritizing areas of study, and directing their efforts toward filling these gaps. Furthermore, our examination underscores the significance of bibliometric analysis as a valuable tool for researchers in various disciplines. It is a powerful means to gauge the evolution of a particular field, identify influential research, and map out emerging trends. As the body of literature surrounding *L. trifolii* continues to expand, the bibliometric approach will remain a vital resource for guiding scholars and policymakers in addressing the challenges posed by this agricultural pest. In summary, this preliminary examination has deepened our understanding of *L. trifolii* and highlighted the potential for extended investigation in this area. By leveraging the insights gained from our analysis, future research endeavors can contribute to more effective pest management strategies, improved agricultural practices, and a more comprehensive understanding of the ecological impact of *L. trifolii*. Ultimately, this study underscores the importance of continued exploration and collaboration within the scientific community to address complex challenges in agriculture and ecology.

Acknowledgements

We would like to express our heartfelt gratitude to the Department of Agronomy, Plant Pathology for their invaluable support and resources throughout the research and creation of this work. Their unwavering commitment to academic excellence has been instrumental in our journey. Furthermore, we extend our sincere appreciation to the authors of this paper, whose dedication, expertise, and collaborative spirit have made this endeavor possible. Each author's unique contributions and insights have enriched the content and depth of our work. We acknowledge the collective efforts of all those involved in this paper, as it would not have been achievable without the department's collaboration and our esteemed authors' dedication.

Conflict of Interest

None.

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