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Climate Change and Plant Health: A Bibliometric Analysis

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ABSTRACT

Climate change, the effects of which are becoming more evident day by day, is seen as a serious threat to sustainable agriculture. As a result of the diseases and pests being affected by climate change, it is inevitable that changes will occur in the state of plant health, which has an important place in sustainable agriculture. Evaluation and analysis of the literature is of great importance, as research and assessments focusing on the impact of climate change on plant health use current knowledge. In this study, which was carried out to contribute to the aforementioned subject, bibliometric analysis was performed on the indexed researches on climate change and plant health in the Web of Science (WoS) database according to the determined search query. Information on different subjects such as authors, countries, published journals, citations, sources used and keywords related to the studies were analyzed with the Bibliometrix package developed in R software and the data were visualized. Quantitative results were obtained on subjects such as prominent authors, journals, countries, and common keywords as a result of bibliometric analyses. According to the results, the importance of multidisciplinary studies is becoming more and more important. In addition, it is gaining popularity to benefit from technological developments in the face of changing and emerging needs in the processing of all kinds of information about climate change. This study was carried out to show that there is an alternative way to gain a general perspective on climate change-related issues in similar studies to be carried out. It is thought that these and similar bibliometric analysis studies can contribute to the execution of more successful studies, thanks to the information on different topics they provide.

1. Introduction

The concept of 'one health', which expresses the whole of human, animal and environmental health, will gain more importance as a result of the increase in their relationship with each other in the changing world conditions with the effect of climate change and other factors. Plant health, which is considered as a sub-branch of environmental health, has a much more important role than it is thought because it is related to food, which forms the basis of human and animal nutrition. Plant diseases have the potential to harm large human populations as a result of their effects such as causing disease in humans and animals, famine due to lack of clean food, acute or chronic poisoning, exposure to pesticides and disruption of natural processes (Andrivon et al. 2022; Morris et al. 2022).

Experiencing devastating events such as drought, flood and extreme weather events with the effect of many factors, especially changes in temperature and CO_2 values, is interpreted as a sign that climate change will have a more serious impact in the future. As a result of the environmental and ecological conditions being affected by the changing conditions, it is inevitable that the sustainable agriculture will be negatively affected. All of the pathogen-host-vector factors that make up the three pillars of plant health are in a very close relationship with the environmental factor. The different situations that arise in plant health with the effects of climate change are a great threat to sustainable agriculture and food security. The necessity of multidisciplinary approaches for understanding and resolving impacts and consequences is now an indisputable reality (Jeger et al. 2021; Malhi et al. 2021; Priyanka et al. 2020).

More studies of important issues and expanding research areas cause the rapid growth of the literature

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and the increase of unexplained information. Bibliometric analysis studies, in which a large number of scientific studies are analyzed, can reveal changes and developments in any subject, make trends and deficiencies visible, and provide researchers with information on many different topics (Donthu et al. 2021). Many bibliometric analyzes have also been made on climate change, which is a hot topic and contains a large amount of data. In relation to climate change and agriculture, Fu and Waltman (2022) on the large-scale climate change research literature, Sweileh (2020) on the climate change and food security literature, Sarkar et al. (2022) on the sustainable agriculture literature, and Yuan and Sun (2022) on the rice and climate change research literature, are examples of bibliometric analysis studies. Bibliometric analysis has been carried out on many issues related to climate change, such as economy, energy, migration, and adaptation.

In our study, it has been shown that a quick perspective can be provided by making bibliometric analyzes on terms related to climate change and plant health, which is a subject that has not been examined before according to our available information.

2. Materials and Methods

In order to obtain material suitable for the purpose of the study, a search was made in the Web of Science (WoS, www.webofknowledge.com) database with the query created on the relevant subject. Search for "TS=(climate change*) AND TS=(plant disease*)", "TS=(climate change*) AND TS=(plant pest*)" and "TS=(climate change*) AND TS=(plant weed*)" queries were used. Search results were processed with tidyverse (Wickham et al. 2019) and bibliometrix (Aria and Cuccurullo 2017) packages developed in R v4.2.1 (R Core Team 2021) software language in R Studio v2022.07.0 (RStudio Team 2020) environment. After merging the query results, the studies were filtered. The studies were limited to those written after 2000, only in the 'article' type and only in English, and the analyzes were carried out on these studies.

3. Results and Discussion

After filtering, bibliometric analyzes were made by considering 3391 of 3902 studies associated with climate change and plant health (in terms of diseases, pests and weeds). Studies have been published in 886 different journals by 12738 different authors in total. The annual growth rate calculated over the distribution of 3391 publications by years was found to be 21.6%. Although there are some fluctuations, it can be seen that the annual number of publications is increasing, suggesting that the subject is being addressed more and more (Figure 1).

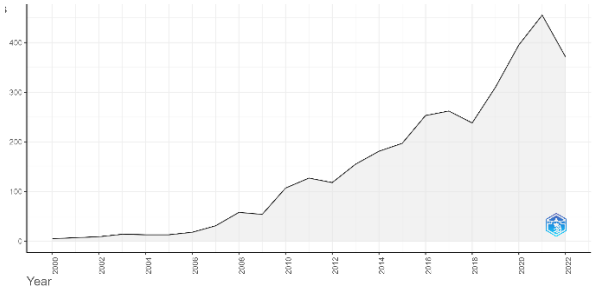

Figure 1
Annual publication increase

Among the 886 different journals in which the publications are included, the fact that the first 20 journals are not specific on the basis of the subject, but are multidisciplinary and have high H-index, shows that plant health and climate change are given importance and are handled in a multi-faceted manner (Figure 2). In terms of the number of publications, PLOS ONE journal ranks first with 92 publications, while FRONTIERS IN PLANT SCIENCE journal ranks second with 63 publications, and GLOBAL CHANGE BIOLOGY journal ranks third with 59 publications. Other journals have ~50 or fewer publications. Unlike the ranking of the number of publications according to the H index, GLOBAL CHANGE BIOLOGY is the first (34) while PLOS ONE is the second (29) and CLIMATIC CHANGE is the third (22).

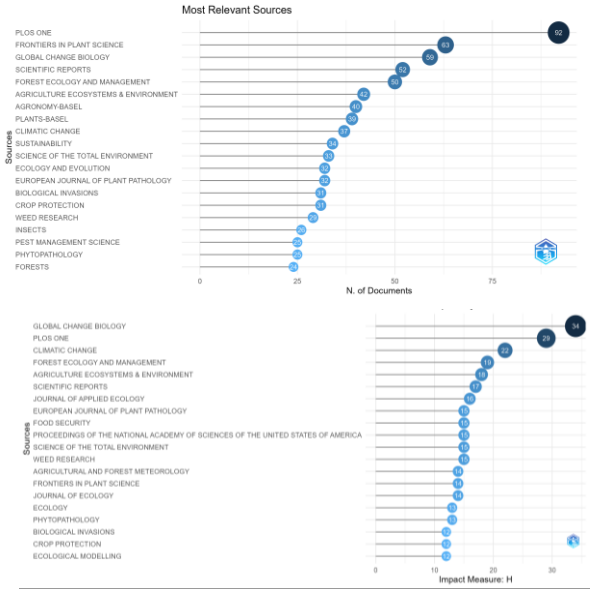

Figure 2
The first 20 journals according to the number of publications (above) and the first 20 journals according to the H index (below)

According to the number of publications, it is seen that the top 20 authors have at least 10 publications and the productivity of the authors in terms of publications has increased after 2010 (Figure 3). The top three authors are Darren Kriticos, Lewis Ziska, and Philip Hulme. When the publication contents of these authors are examined, it is seen that they have extensively covered topics such as ecology, ecosystem, biodiversity,

control strategies, invasive species, or have developed models and software for analyzes on various subjects. For example, Daren's modeling tool named CliMond (Kriticos et al. 2012), Lewis Zisca's studies (Hatfield et al. 2011) on the effects of climate change on agriculture, Philip Hulme's studies (Walther et al. 2009) on invasive species in a warming worldare among the highly cited studies. In general, there is an average of 5.2 authors per publication and the number of single-authored studies is 146, while the international co-authorship rate is 35.7%.

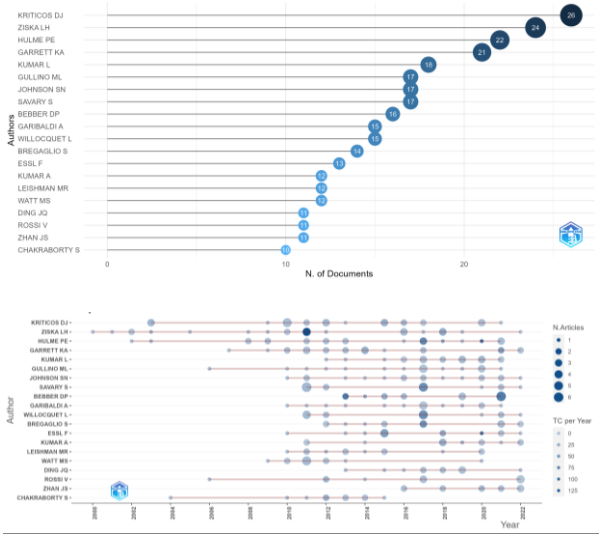

Figure 3
Top 20 authors by number of publications (above) and their productivity by years (below)

Looking at the first 20 publications among the analyzed studies, it is seen that they received at least 360 citations (Figure 4). For example, studies on tree death due to drought (Allen et al. 2015), interaction between species in climate change (Gilman et al. 2010), and the consequences of climate change for invasive species (Hellmann et al. 2008) are the three most cited studies among the analyzed studies. The relatively broad perspective of these studies provides evidence for the necessity of a multidisciplinary approach to the subject.

When the citations made in the analyzed studies are examined, it is seen that there are studies that provide an overview on certain topics (Figure 4). From genomes to ecosystems, the effects of climate change on plant diseases (Garrett et al. 2006), the direct effects of increasing temperature on herbivorous insects (Bale et al. 2002), climate change and plant disease management (Coakley et al. 1999) studies are among the most cited studies in the analyzed studies. The high citation of studies on a more specific subject such as plant health shows that the subject we have examined has been addressed in many studies and is an important subject to be investigated.

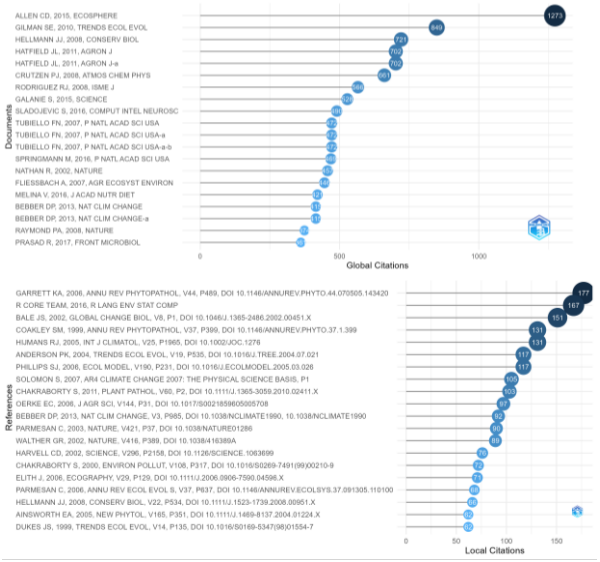

Figure 4
Among the studies we analyzed, the top 20 most cited studies (above) and the top 20 most cited studies by analyzed studies (below)

In addition, it is an interesting result that R software (R Core Team 2021) ranks second among the most cited studies. This result shows that software and analysis programs are used extensively in publications on climate change and plant health. It is thought that the need to develop new software and programs for changing needs may arise in future analyzes. While the developments in artificial intelligence and machine learning technologies in recent years have made important contributions to the analysis and interpretation of all kinds of data, the accuracy of the data is now becoming more important for correct predictions.

When the keyword plus words revealed by the Web of Science database according to the contents of the studies were evaluated, it was determined that while climate change (1078) was the most frequently used keyword, words such as temperature (305), growth (285), management (263), responses (233), impacts (219), resistance (218), plants (202), diversity (201) were also frequently used (Figure 5).

On the other hand, when the 50 most used author keywords in the analyzed publications were evaluated, it was found that climate change (874) was the most frequently used keyword, while it was frequently used in words such as invasive species (90), agriculture (85), food security (82), adaptation (80), global warming (73), biodiversity (71), drought (70), temperature (70) (Figure 5). These results show that the authors use relatively more general keywords.

Figure 5
Word cloud created according to the frequency of use of keyword plus (above) and author keywords (below)

When the author keywords are examined by years, it is seen that the keywords of gene editing and intercropping, together with the terms of machine learning and deep learning related to artificial intelligence, have been trending in recent years (Figure 6). These results are proof that research subjects are rapidly shifting to that field according to changes and developments.

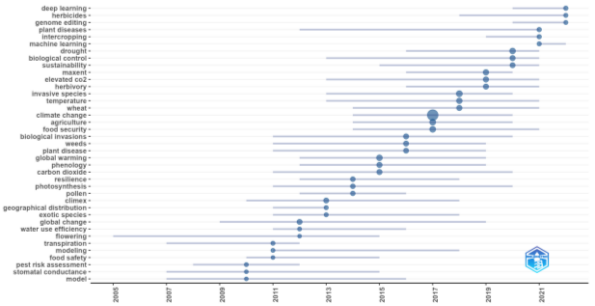

Figure 6
Change of author keywords by years

When we look closely at the relations between journals, it can be seen that there is a grouping of journals with relatively ecology-based multidisciplinary content or general coverage and phytosanitary-based journals. (Figure 7). However, even if grouping is mentioned, the fact that all journals have a large number of relations with each other in one way or another strengthens the multidisciplinary understanding.

When publications are associated with countries through authors, the USA (633) ranks first in terms of total publications, both within itself (507) and in cooperation (126) with multiple countries, followed by countries such as China (286), Australia (262), United Kingdom (204), and India (168). The top 10 countries in terms of the number of citations received are listed as USA, UK, Australia, Italy, Germany and others in parallel with the number of publications, although there are some differences (Figure 8). It is considered as an important inference that China and India, which are in the first place in the number of publications, cannot show the same success in citation. As in our results, it was determined in Fu and Waltman (2022) study that there is a difference between developed and developing countries in scientific production.

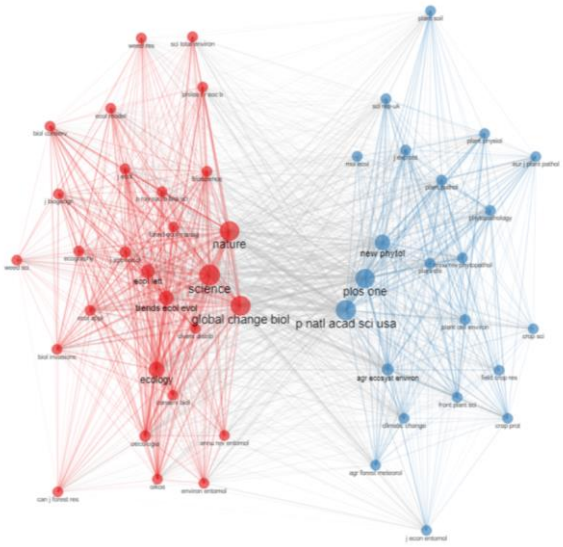

Figure 7
Relationship between journals

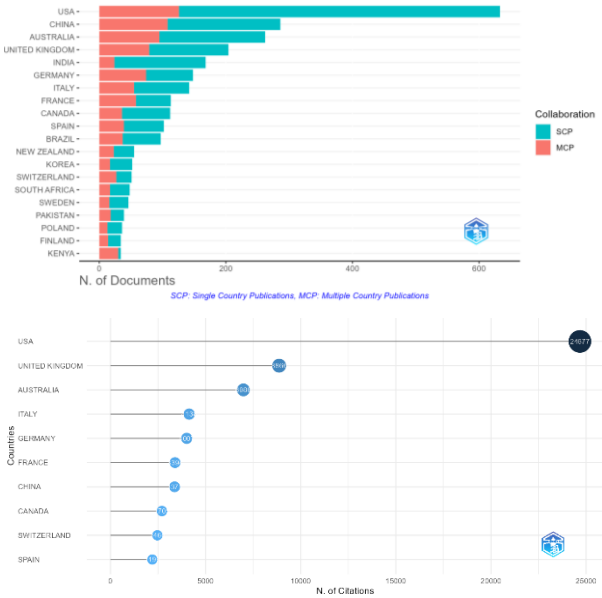

Figure 8
Ranking of countries (top 10) in terms of number of collaborations (above) and number of citations by country (top 20) (below)

When publications are associated with universities, institutions and departments through the authors, the USA has the highest number of units among the top 20 institutions, while countries such as China, Australia and England have more than one unit. The differences in unit names such as policy, management, plant pathology, plant sciences, biodiversity, environment, ecology and ecosystem suggest that the subject is handled from multiple perspectives. (Figure 9).

Figure 9
Top 20 organizations in terms of number of publications

As a result, bibliometric analyzes are a useful method for making many information inferences as well as providing an overview of the subject being studied (Donthu et al. 2021; Moral-Muñoz et al. 2020). Bibliometric analyzes can enable researchers, academic journal management, planning and decision-making management bodies such as universities and government institutions to obtain useful information about countries, people, journals, institutions and different (missing, potential or priority) points related to any subject. Other researchers mention similar benefits of bibliometric analyzes in their studies (Donthu et al. 2021; Fu and Waltman 2022; Yuan and Sun 2022).

Due to the wide scope of the subject we examined in our study, it can be difficult to make sense of the diversity other than certain names that come to the fore. Performing bibliometric analysis by limiting the subject can be a solution to overcome this deficiency. On the other hand, meticulous control of the analyzed data can provide more accurate results. It is thought that this study can provide a limited but general overview in the light of bibliographic information on plant health and climate change, as well as being a guide for similar analyzes. In order to reduce the possible effects of climate change on plant health and contribute to the sustainability of agriculture, there is a need for more multidisciplinary studies to be conducted and the information produced to be processed.

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