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Research Article

A Bibliometric Analysis and Visualisation of Research Trends in Oak Wilt

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ABSTRACT
Oak wilt is a fungal infection, caused by "Bretziella fagacearum". This plant disease affects the water transportation systems in plants and finally results in the death of the tree. This disease can cause both ecological and economical repercussions. This bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "oak wilt". All published articles related to "oak wilt" from "Scopus", were analyzed using the VOS viewer to develop analysis tables and visualization maps. This article had set the objective to consolidate the literature regarding the oak wilt and also to find out the trends related to the same. Plant Disease is the most active journal and Ecology is the journal with the highest citations. Journal of Microbiology and Biotechnology is the journal having the highest average citations. The most active country is the USA and the United Kingdom is the country with the highest average citations per publication. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute of South Africa is the most active organization. All the top five organizations with the highest average citations are from South Korea. The most active author is Juzwik.J. and Appel D.N. is the author with the highest citations.

Keywords: Oak wilt, Bibliometric analysis, VOS viewer, Plant disease

INTRODUCTION

Oak wilt is a fungal infection, caused by "Bretziella fagacearum". This plant disease affects the water transportation systems in plants and finally results in the death of the tree. This disease can cause both ecological and economical repercussions (Wilson, 2001). Red oaks and black oaks are more vulnerable to this fungus than white oaks. This fungal infection is transmitted in several ways like through wind, plant wounds, root to root transmissions, and insect vectors (Jennifer Juzwik, David N Appel, William L MacDonald, 2011). Removal of infected trees, avoiding pruning of oak trees from April to July, avoiding and prompt treatment of wounds, sterilization of farming equipment are some measures to prevent oak wilt disease (Koch, Quiram, and Venette, 2010). As there is no perfect cure for oak wilt, treatments are expensive and strong resistant variants are yet to be developed, rigorous research is required regarding oak wilt.

This bibliometric article is arranged in four sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion.

RESEARCH METHODOLOGY

Research Objectives

a) To consolidate the literature regarding the oak wilt
b) To find out the trends related to research in the oak wilt

The following research questions are framed for conducting bibliometric analysis systematically.

Research Questions

a) Which are the main journals and articles working related to oak wilt?
b) Which are the main organizations and countries working on oak wilt?
c) Who are the active researchers working on oak wilt?

Only the Scopus source had been used in this bibliometric analysis. For the article selection, the Boolean used was "TITLE-ABS ("OAK WILT")" on 19/11/2020. The first three figures were created using Microsoft Excel and "VOS viewer version 1.6.15" was used for the creation of figures 4-7. Similarly, all the tables in this paper were created by using Microsoft Excel and VOS Viewer. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation.

This paper had been inspired by bibliometric analysis in its presentation style, analysis, and

methodology from the works (Sinha, 1980), (Kappel et al., 2012), (Soosaraei et al., 2018), (Garrigos-simon and Botella-carrubi, 2018), (Li et al., 2019), (Mas-tur and Guijarro, 2019), (Hong et al., 2019), (Winkowski, 2019), (Wang, Xu, and Škare, 2020), (Heshmati and Hashempour, 2020), (Ivanov et al., 2020), (Gao et al., 2020), (Patil and Kumar, 2020).

Methods and Tools for Evaluation

Co-authorship analysis measures the relatedness of items based on the number of co-authored documents. Co-authorship analysis can be possible with three units of analysis, namely, authors, organizations, and countries. Co-authorship analysis had been conducted by analyzing the number of co-authored documents, citations, and average citations per co-authored documents and link strength to identify the closely related authors in a research area.

Co-occurrence analysis measures the relatedness of items based on the number of documents in which the keywords occur together. Co-occurrence analysis can measure the trends in research. Co-occurrence analysis can be possible with three units of analysis, namely, author keywords, index keywords, and all keywords. The trending keywords and the trend in research are identified by finding out keywords with the highest occurrence and link strength. We had used all keyword analysis for this bibliometric review.

Citation analysis can be possible with five units of analysis, namely, authors, documents, sources, organizations, and countries. For citation analysis, total publications, total citations, citations per document, co-citation links, and percentage of total citations were used. H-index data from "Scopus" were also used along with citation analysis to identify the most effective journals and countries engaged in the research domain of "Oak wilt".

RESULTS AND DISCUSSION

This first round of search produced an outcome of one hundred and seventy-three documents, in the six languages. The classification of documents based on language is shown in figure 1. The various types of documents and their details had been shown in figure 2. Moreover out of the total documents, forty-seven documents were of open access. After using filters "Article" and "English", the second round search produced an outcome of one hundred and thirty-three English articles (both open access and others). All one hundred and thirty-three English articles had been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this research domain since 1954 had been shown in figure 3.

Figure 1: Classification of documents on the basis of languages

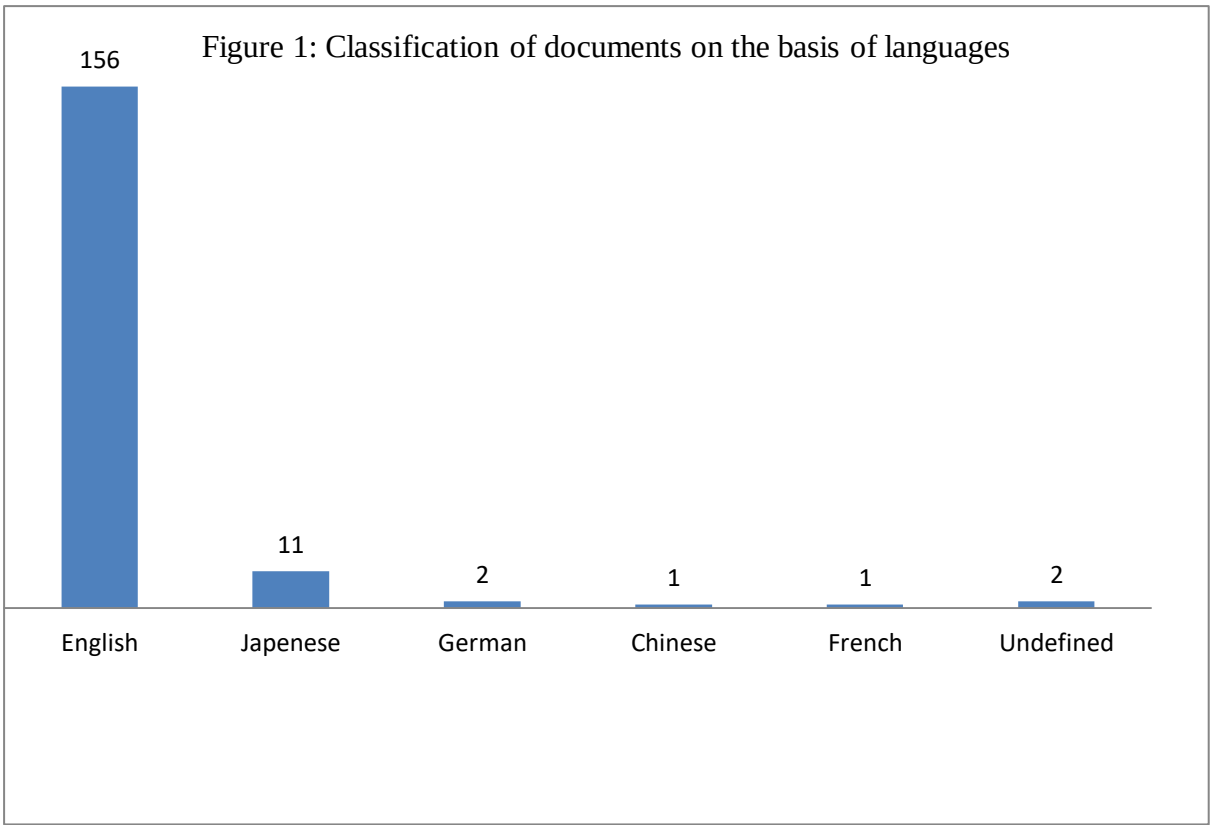

Figure 2: Percentage of various types of documents

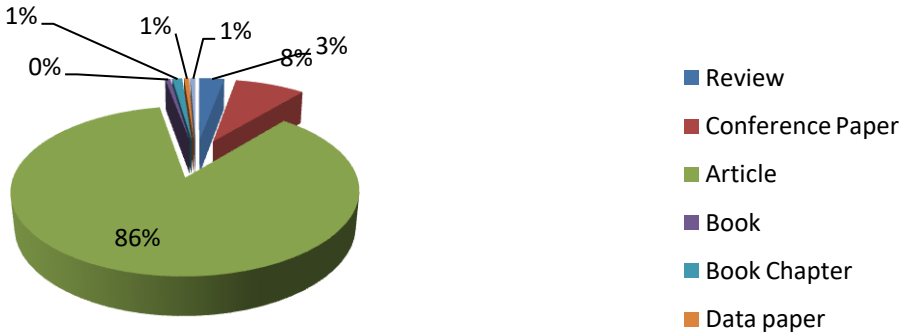

Figure 3: Period wise publication

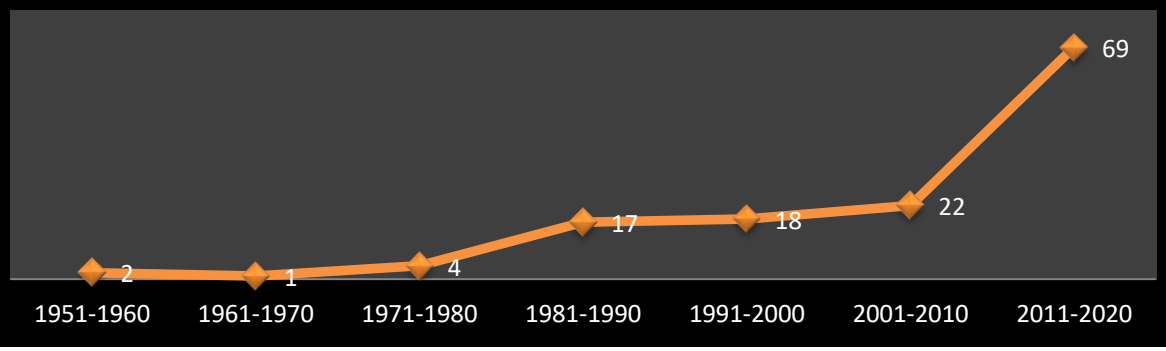

Table 1 shows the details with active researchers in the domain of "Oak wilt". Co-authorship analysis and citation analysis were used in this research. For co-authorship analysis, the parameters selected was, the minimum number of documents of an author as three and the minimum number of citations of authors as one. This combination plotted the map of twenty-four authors, in twelve clusters. The overlay visualization map of co-authorship analysis plotted in figure 4, points out the major researchers with their strong co-authorship linkages and clusters involved.

The most active author is Juzwik.J. with the highest number of publications and highest co-authorship links. Appel D.N. is the author with the highest citations. The details of authors with the highest average citation are provided in table 1.

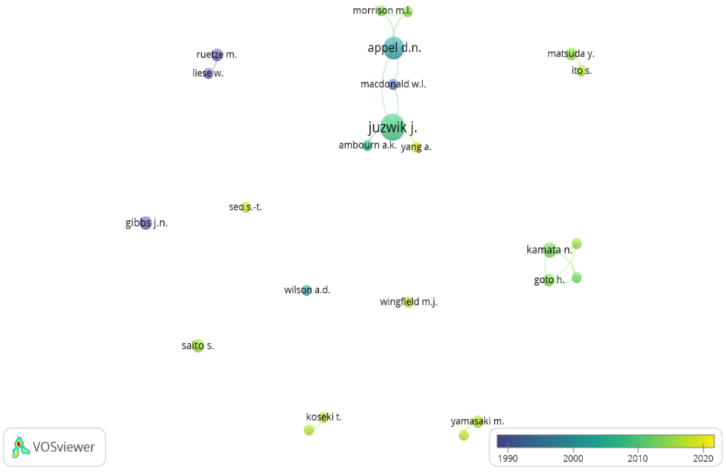

Fig.4: Co-authorship analysis on basis of authors

Table 1: Highlights of Most Productive and Active Authors

Highlights of Authors with the Highest Publication and Co-authorship Links				
Authors	Documents	Citations	Average Citations per Documents	Link Strength
Juzwik J.	18	169	9.388889	50
Highlights of Authors with the Highest Citation				
Authors	Documents	Citations	Average Citations per Documents	Link Strength
Appel D.N.	13	256	19.69231	33
Highlights of Authors with the Highest Average Citation				
Authors	Documents	Citations	Average Citations per Documents	Link Strength
Chang S.-J.	1	139	139	10
Jung M.	1	139	139	10
Kim H.-S.	1	139	139	10
Kim J.K.	1	139	139	10
Kim K.S.	1	139	139	10
Kim S.B.	1	139	139	10
Kim S.W.	1	139	139	10
Kim Y.-J.	1	139	139	10
Lamsal K.	1	139	139	10
Lee Y.S.	1	139	139	10
Sim S.-J.	1	139	139	10

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as ten. This combination plotted the map of twenty-seven thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in figure 5.

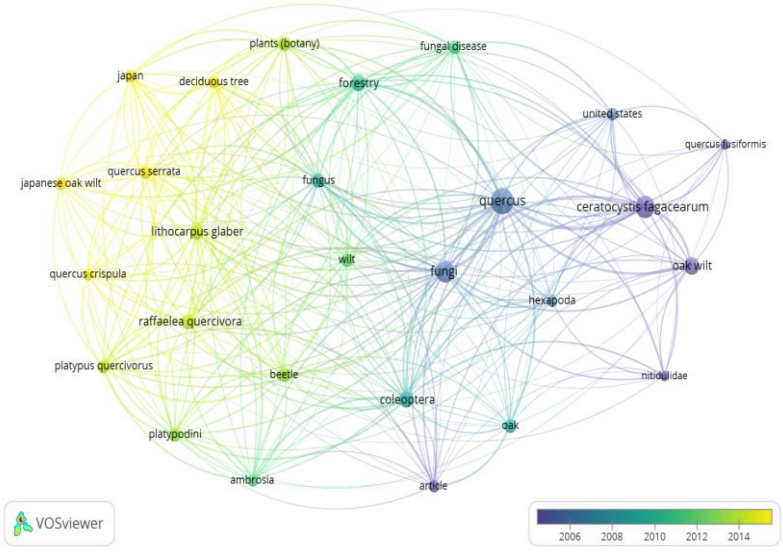

Fig.5: Co-occurrence analysis on basis of all keywords

Table 2 and figure 6 show the most active and productive organizations engaged in research on "oak wilt". While taking organizations as a unit of analysis for the co-authorship analysis, we have

taken the parameters of the minimum number of documents of an organization as two and the minimum number of citations of organizations as one. This combination plotted the map of fourteen organizations, in eight clusters.
Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute of South Africa is the most active organization with the highest co-authorship links and highest number of publications. Department of Chemistry, Postech; Division of Bio-Resources Technology, Kangwon National University; Division of Forest Resources, Kangwon National University; Forest Research Institute of Gangwon Province; School Of Technology Management, Ulsan National Institute of Science and Technology were the top five organizations with the highest average citations and all the five organizations are from South Korea.

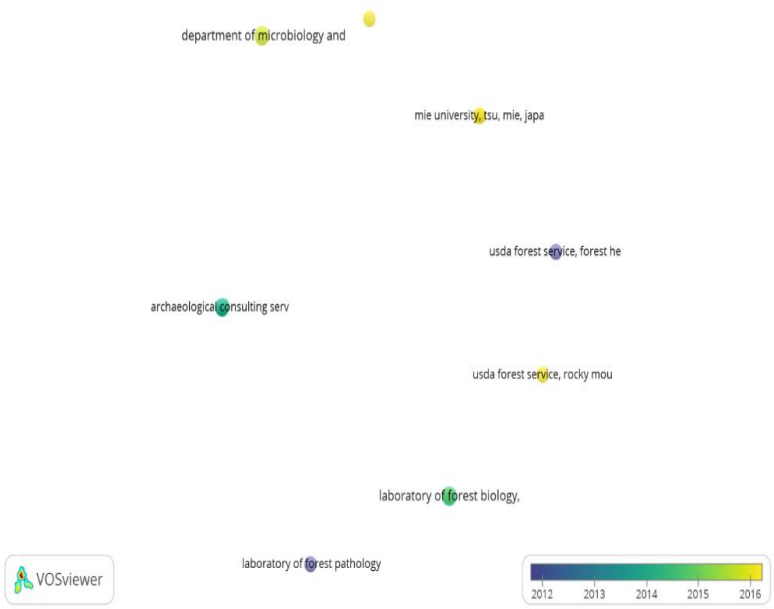

Fig.6: Co-authorship analysis of organizations

Table 2: Highlights of Most Productive and Active Organisations

Highlights of Organisation with the highest publication and co-authorship links					
Organizations	Country	Documents	Citations	Average Citations per document	Link Strength
Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute	South Africa	3	56	18.67	11
Highlights of Organisation with the highest citation and highest average citation					
Organizations	Country	Documents	Citations	Average Citations per document	Link Strength
Department of Chemistry, Postech	South Korea	1	139	139	4
Division of Bio-Resources Technology, Kangwon National University	South Korea	1	139	139	4
Division of Forest Resources, Kangwon National University	South Korea	1	139	139	4
Forest Research Institute of Gangwon Province	South Korea	1	139	139	4
School Of Technology Management, Ulsan	South Korea	1	139	139	4

National Institute of Science and Technology					

Table 3 and figure 7 shows the countries actively engaged in research on "oak wilt". Co-authorship analysis and citation analysis were used in this analysis. While taking countries as a unit of analysis for the co-authorship analysis, we have taken the parameters of the minimum number of documents of a country as one and the minimum number of citations of a country as one. This combination plotted the map of thirty-one thresholds in thirteen clusters.

The most active country is the USA with the highest number of publications, highest citations, and the highest co-authorship linkages. The United Kingdom is the country with the highest average citations per publication.

Table 3: Analysis of activities of countries

Highlights of Countries with the Highest Publications, Citations, and Co-authorship Links				
Countries	Documents	Citations	Average Citations Per Documents	Link Strength
United States	62	792	12.77	11
Highlights Of Countries With The Highest Average Citation				
Countries	Documents	Citations	Average Citations Per Documents	Link Strength
U.K	1	19	19	2

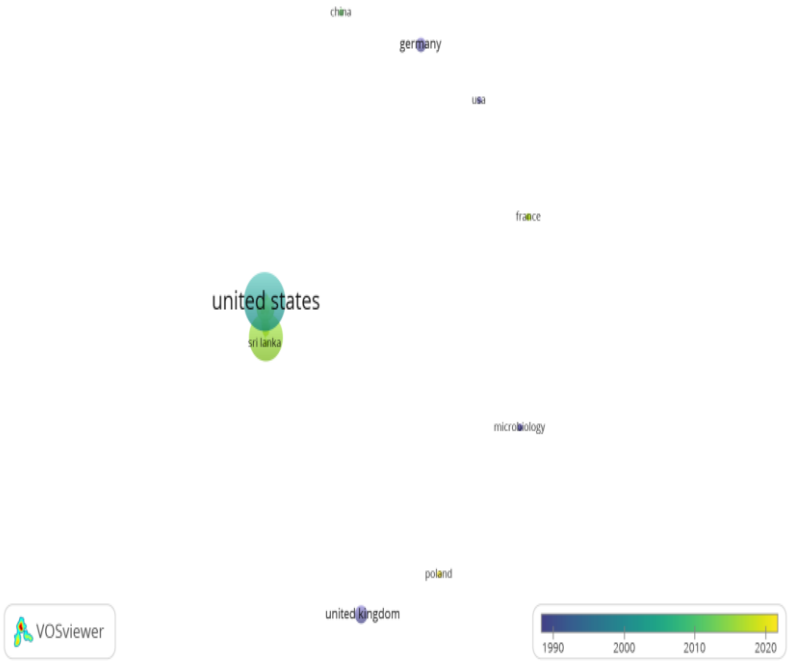

Fig.7: Co-authorship analysis of countries

Table 4 and figure 8 shows the highly cited articles, engaged in research on "oak wilt". Citation analysis was used and we have taken the parameters of the minimum number of citations as ten.

Table 4: Details of highly cited articles

Articles	Citations	Details Of Journal And Publisher	Title
Kim S.W. (2009)	139	Journal of Agricultural and Food Chemistry, American Chemical	Male-Produced Aggregation Pheromone Blend in Platypus Koryoensis

		Society, USA	
Brooks D.S. (1994)	95	Biological Control, Acedamic Press Inc, USA	Evaluation of Endophytic Bacteria as Potential Biological Control Agents for Oak Wilt

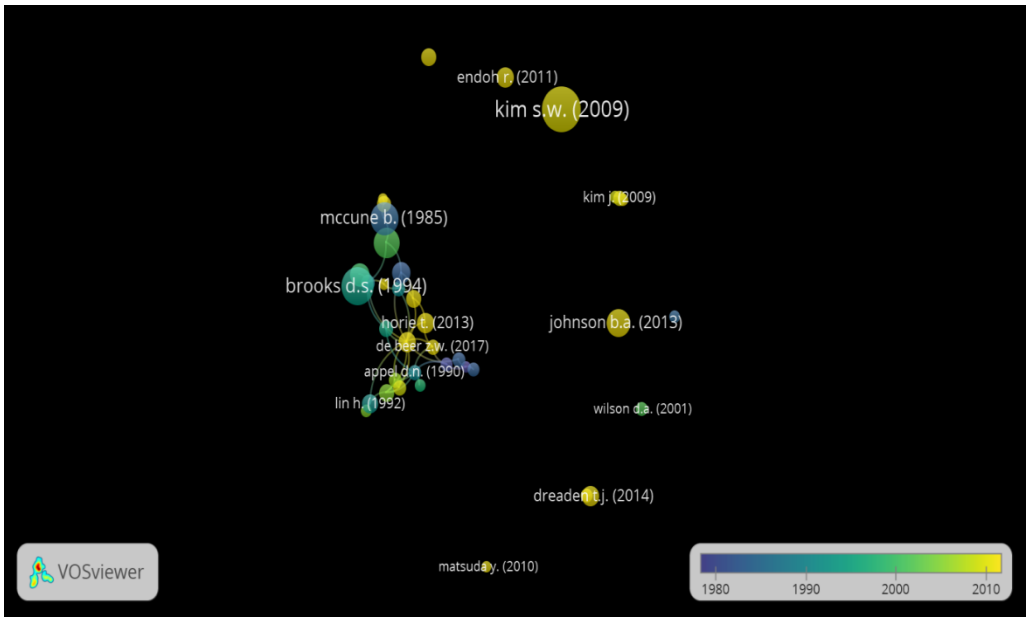

Fig.8: Citation analysis of highly cited articles

Table 5 shows the journals actively engaged in research on "oak wilt". Link analysis and citation analysis were used in this analysis. We have taken the parameters of the minimum number of documents of a journal as one and the minimum number of citations of a journal as one. This combination plotted the map of sixty-seven thresholds in twenty-one clusters.

Plant Disease is the most active journal with the highest publication and co-authorship links. Ecology is the journal with the highest citations and Journal of Microbiology and Biotechnology is the journal having the highest average citations. H-index and publisher details of the top journals had highlighted in table 5 for reference.

Table 5: Analysis of journal activity

Highlights Journals with the Highest Publication and Co-authorship Links						
Journals	Documents	Citations	Average Citations per documents	Link Strength	H-Index	Publisher
Plant Disease	8	124	15.5	51	102	American Phytopathological Society, USA
Highlights Of Journals With Highest Citations						
Journals	Documents	Citations	Average Citations per documents	Link Strength	H-Index	Publisher
Ecology	3	170	56.67	10	279	Wiley-Blackwell, USA
Highlights Of Journals With Highest Average Citations						
Journals	Documents	Citations	Average Citations per documents	Link Strength	H-Index	Publisher
Journal of Microbiology and Biotechnology	1	139	139	1	59	Korean Society for Microbiology and Biotechnology, South Korea

CONCLUSION

The results and discussions in the above section had identified the most active authors, organizations, countries, and journals engaged in the research regarding Oak wilt disease. Plant Disease is the most active journal with the highest publication and co-authorship links. Ecology is the journal with the highest citations and Journal of Microbiology and Biotechnology is the journal having the highest average citations. The most active country is the USA with the highest number of publications, highest citations, and the highest co-authorship linkages. The United Kingdom is the country with the highest average citations per publication. Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute of South Africa is the most active organization with the highest co-authorship links and highest number of publications. Department of Chemistry, Postech; Division of Bio-Resources Technology, Kangwon National University; Division of Forest Resources, Kangwon National University; Forest Research Institute of Gangwon Province; School Of Technology Management, Ulsan National Institute of Science and Technology were the top five organizations with the highest average citations and all the five organizations are from South Korea. The most active author is Juzwik.J. with the highest number of publications and highest co-authorship links. Appel D.N. is the author with the highest citations. This analysis in this paper recommends further research regarding oak wilt. Oak wilt offers a new avenue for researchers. The future research can be on disease control, developing chemical control measures, identifying new biological control measures, and development of resistant variants.

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