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Bibliometric Analysis in Scientific Articles on Nitrogen Fixation of Legumes

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Abstract: Legumes has a great important in sustainable agriculture because roots are aerate and improve the physical, chemical and biological properties of soil. Legumes also enrich soil for nitrogen throughout symbiotic nitrogen fixation by rhizobia bacteria in nodules on roots and they provide products with low input. There are many studies about nitrogen fixation in legumes. However, indicating status and trends of researches are great important by bibliometric analysis. Bibliometric analysis is a useful method in literature review that reveals where research is done on a topic, models and mapping of research fields. In this study, 356 publications on nitrogen fixation of legumes between 1980-2023 were investigated using Web of Science (WoS) data and VOS viewer programme by bibliometric analysis methods. The highest number of publication on nitrogen fixation of legumes was produced in 1987, while the lowest one was in 1989. The most citation was achieved from year of 2021 with 1038 while the lowest was in 1980. Peoples, M., Sprent, J. and Urquiga, S. had highest number of publication. Plant and Soil has the most record count of publications. The organization with most publications was CSIRO. Swedish University of Agricultural Sciences had 438 citations with 6 documents while CSIRO had the 400 citations with 14 documents. USA and Australia had the highest numbers of publications. As a results, the study revealed fields of research, identify the main journal, authors, countries, research trends on nitrogen fixation of legumes by bibliometric analysis methods.

Keywords: Bibliometric analysis, Legumes, Nitrogen fixation

Introduction

Legumes (*Leguminocea*e) one of the most important plant familia and are used for human diet, livestocks feeding, medical, paper and furniture industry, fuel at the worldwide. Legumes roots prevent erosion and improve the physical, chemical and biological properties of soil (Jensen & Hauggard Nielsen, 2003). Legumes also enrich soil for nitrogen throughout symbiotic nitrogen fixation by rhizobium bacteria that form nodules on roots. Nitrogen is essential plant nutrient for plant growth. Yield can be increased by chemical fertilizer, but different problems occured in soil. Chemical fertilizer production is difficult and expensive. Therefore, production cost for crop increases and fertilizer degrades physical properties of soil. Importance of symbiotic nitrogen fixation in agriculture is increasing due to environmental problems arised in the use and production of nitrogen fertilizer. Amount of biological nitrogen fixation in the world is about 175 million ton year. About 50% of nitrogen fixed is provided through symbiotic of legume-rhizobium (Sarıoglu et al., 1993). Legumes can be used as green manure in cropping system. It provides nitrogen mineral matter and humus contents in soil. Legumes should be considered in the development of future agroecosystem (Jensen et al., 2012). Nitrogen fixation is affected different environmental condions (Rao & Rupela, 1998). Nitrogen fixed by pulses ranges from 65 to 224 kg ha^{-1} (Nutman,1976). Nearly 30-40 kg of N is fixed on plant for each ton dry matter produced by legume crops (Peoples et.al., 2009). There are many studies about nitrogen fixation by various legumes under different environmental conditions (Gibson et al., 1982; Zahran,1999; Pampana et al., 2018; Fenta et al., 2020). However, indicating status of research and trends are great important by bibliometric analysis. Bibliometric analysis is a useful method in literature reviews that reveals where research is done on a topic, models and

mapping of research field (Şimşir, 2021; Silva et al., 2022; Akşahin & Gülser, 2022; Akşahin & Ortaş, 2022). Many studies were conducted in legume mycorrhiza field (Xu, 2021), maize–soybean intercropping (Feng et al., 2022), various legumes such as chickpea, common beans (Jinfeng et al., 2015; Antunes et al., 2019; Magrini et al., 2019; Spatti et al., 2021; Bhat et al., 2022) by using bibliometric analysis methods for determining the trends of researches.

In this study, publications on nitrogen fixation by legumes between 1980-2023 were revealed using WoS data and VOS viewer programm throughout bibliometric analysis. The aim of the study is determine fields of research, identify the main journal, authors, countries, research trends conducted on nitrogen fixation by bibliometric analysis methods. The results of bibliometric analysis on nitrogen fixation will be guiding to researchers for future studies.

Materials and Methods

Analysis of Data

Dataset was provided from the Web of science (WoS) database. The WoS is one of the most resources evaluated in bibliometric analysis in the World (Magrini et al., 2019). The Wos ‘‘corre collection’’ includes about million records. In this research, 356 publications between 1980-2023 years in 23.04.2023 were found by considering title of legume and nitrogen fixation in the database. Data reached from WoS database were investigated according to name of publication, co- authors of author citation, journal, country, organization, keywords. The bibliometric analysis steps was identifiying keywords, selection of search results, recording and control of WoS files, entering data into vosviewer, creating data maps respectively (Aksahin & Ortas, 2022). Bibliometric analysis map was created for the foremost authors with minimum number of documents and citations. Bibliometric analyzed by using the VOS- viewer, 1.6.19 software (Vosviewer, 2023).

Results and Discussion

The Number of Publications and Citations on Nitrogen Fixation by Legumes

Scientific publications on legumes and nitrogen fixation the years between 1980-2023 were evaluated. (Figure 1). The highest number of publication was produced in 1987 with 16 while the lowest one is in 1989 with 2. Number of citations are 356 during 43- years and it increased in the recently. The highest number of citation was achieved from year of 2021 with 1038 while the lowest was in 1980 with 1. Generally, number of citation increased due to increasing publications.

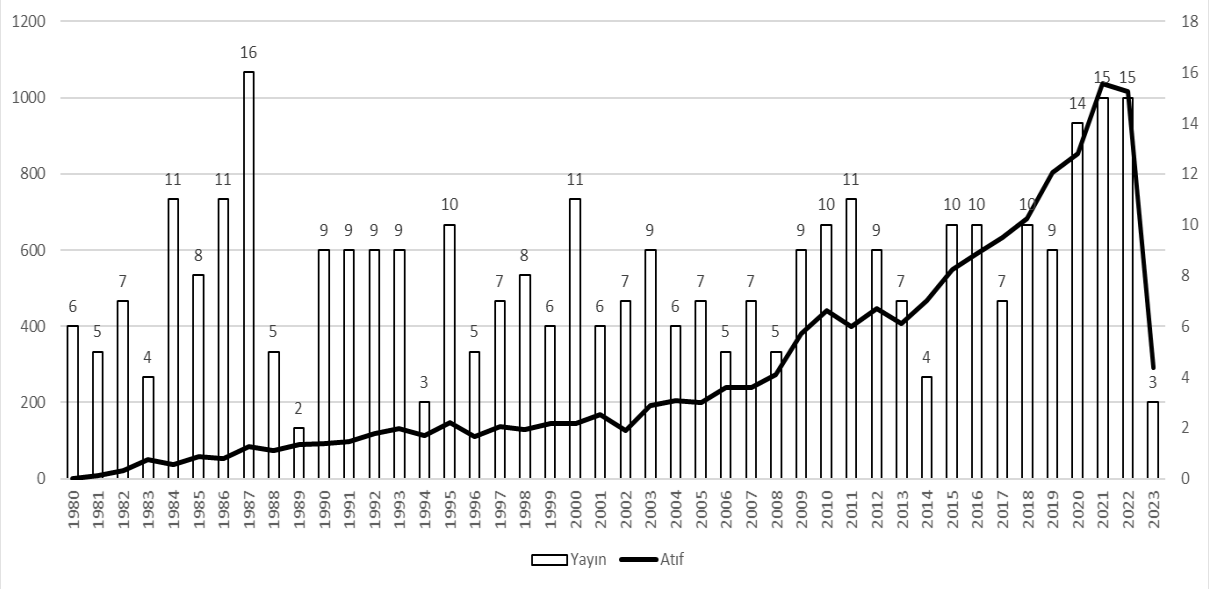

Figure 1. The number of publications and citations produced during last 43- year period.

Journals with the most Publications on Nitrogen Fixation by Legumes

In the 10 top ranking Journal Plant and Soil has the most record count of publications with 43 (12.08%) followed by Field crops Research with 12 record count (3.37 %) between 1980-2023 (Table 1).

Table 1. The top 10 ranking by number of journal between years 1980-2023

No	Publication titles	Record count	Percentage*
1	Plant and Soil	43	12.08
2	Field Crops Research	12	3.37
3	Frontiers in Plant Science	9	2.53
4	New Phytologist	8	2.25
5	Australian Journal of Agriculture Research	7	1.97
6	Biology and Fertiliy of Soils	7	1.97
7	Soil Biology Biochemistry	7	1.97
8	Agronomy Journal	6	1.69
9	Nutrient Cycling in Agroecosystems	6	1.69
10	Annals of Botany	5	1.40

*Percentage of total publications between 1980-2023 years (23.04.2023)

Co-Authorship and Authors with the most Publications on Nitrogen Fixation by Legumes

Bibliometric analysis map for the 10 top authors with at least 1 or more publications was presented in Table 2. Peoples, M., Sprent, J. and Urquiga, S. had highest publication with 6 in the top 10 ranking. Citation number of Ledgard, S with 462 was more than Peoples, M with 393, however documents of People, M was higher than Ledgard, S (Table 2).

Table 2. Co-authorship and authors with the most publications and citations

No	Author	Documents	Citations
1	Peoples, M	6	393
2	Sprent, J	6	211
3	Urquiga, S	6	78
4	Ledgard, S	5	462
5	Herridge, D	5	310
6	Bergersen, F	5	125
7	Sheehy, J	5	119
8	Giller, KE	5	39
9	Serraj, R	4	145
10	Rupela O	4	141

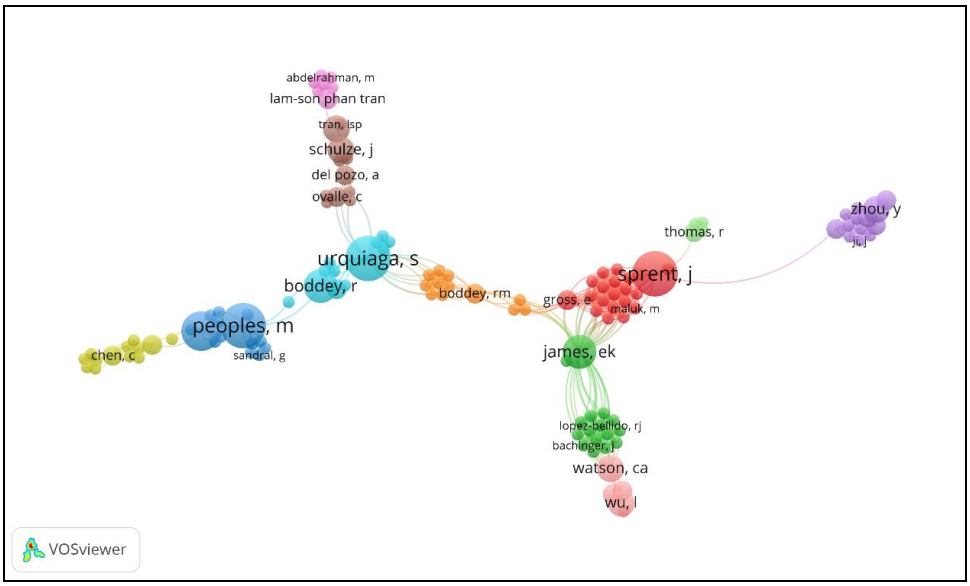

Figure 2. Bibliometric analysis map for foremost co-authorhsip and authors

Authors were grouped into 11 various cluster for the most publications. Cluster 1 included to have highest number of publication author (Figure 2). Each clusters shows that there are related to between publication and authors with same color in graph (Ponomariov & Boardman, 2016; Cevik, 2021). Glänzel and Schubert (2004) reported that co-authorship is showing research collaboration between regions, institutions and countries. Co-authorship is content measure of research collaboration that is two and more individuals are listed as co-authors on the same publication (Ponomariov & Boardman, 2016)

Most used Keywords used on Nitrogen Fixation and Legume

Keywords show the study fields in the researches of nitrogen fixation by legumes and their changes in various periods. Keywords used at least 2 in publications on legume and nitrogen fixation was given in Table 3. Nitrogen fixation was used the most keywords with 46 occurences followed by legumes and legume with 33 and 22, respectively (Table 3 and Figure 3). Keywords were grouped into 14 various clusters (Figure 3). Each cluster shows that relationship between key words. The components with same color used same keywords. Keyword is essential that reach to information about scienfitic research (Su & Lee, 2010; Tripathi et al., 2018; Deka & Sarmah, 2020).

Table 3. Keywords used at least 2 times

No	Keyword	Occurences
1	Nitrogen fixation	46
2	Legumes	33
3	Legume	22
4	Symbiosis	19
5	Nodulation	19
6	Rhizobia	18
7	Biological nitrogen fixation	17
8	N_2 fixation	12
9	Symbiotic nitrogen fixation	10
10	n15	10

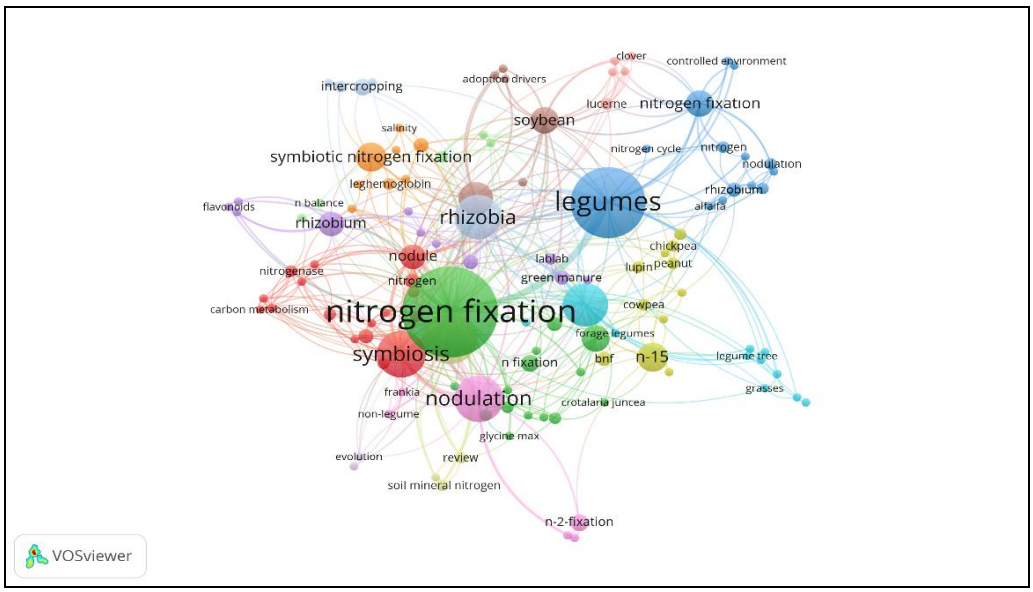

Figure 3. Bibliometric analysis map for foremost keywords used at least 2 times.

Countries with the most Publications on Nitrogen Fixation by Legumes

Bibliometric analysis map for the countries was shown in Figure 4. Countries with highest with publications was USA with 68 followed by with Australia 67. Other most productive countries were United Kingdom with 33 China with 25, Brazil and India with 22 about nitrogen fixation by legumes, respectively.

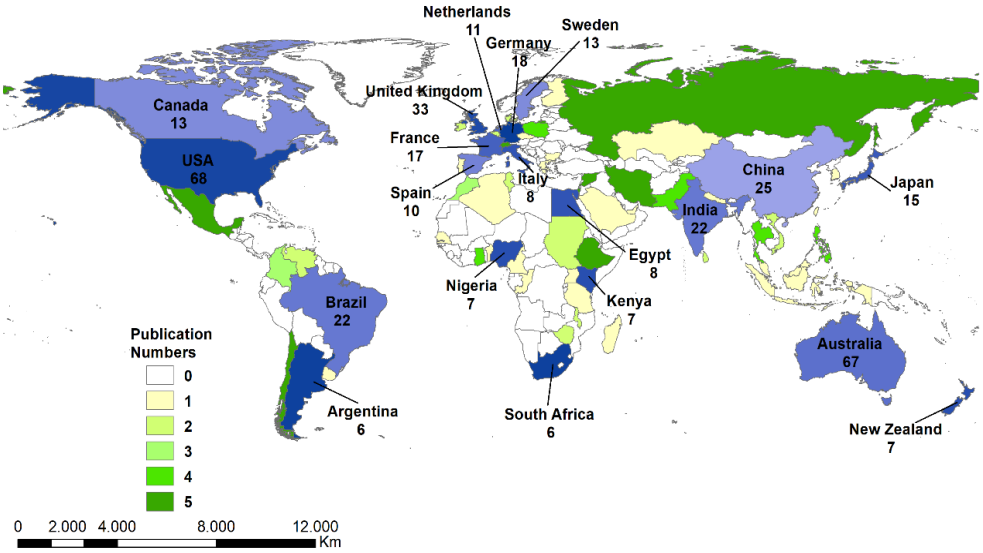

Figure 4. Bibliometric analysis map for the countries for number of publication.

Organization with the most Publications and Citations on Nitrogen Fixation by Legumes

Bibliometric analysis for the 10 top organization with at least 1 or more publications and citations was presented during the 43-years in Table 4. The organization with most publications was CSIRO and Chinese acad sci with 14 and 10 publications respectively. Swedish University of Agricultural Sciences had 438 citations with 6 documents while CSIRO had the 400 citations with 14 documents.

Table 4. The top 10 ranking citations and publications by number of organization

No	Organization	Documents	Citations
1	Csıro	14	400
2	Chinese acad sci	10	138
3	Embrapa agrobiol	7	130
4	Nsw agr	7	267
5	Swedish univ agr sci	6	438
6	Murdoch univ	6	229
7	Univ western australia	6	184
8	Univ adelaide	5	129
9	Univ chinese acad sci	5	107
10	Univ minnesota	5	93

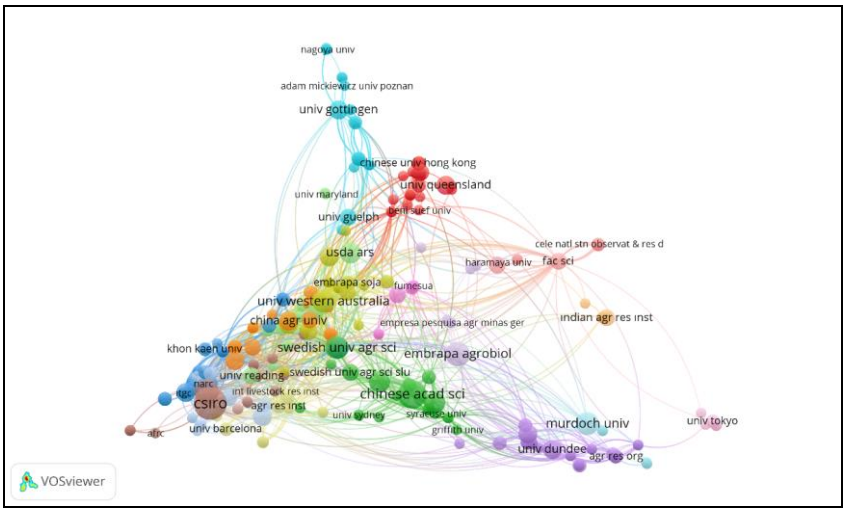

Figure 5. Bibliometric analysis map for foremost the organization with at least 1 or more publications and citations

Organization were grouped into 18 various clusters for most citation. Clusters with same color show that relationship among the cited organization and shows how they are distributed (Van Eck and Waltman, 2014; Van Eck and Waltman, 2017). Cluster 1 included to have highest number of cited organization followed by cluster 2 (Figure 5).

Publications with the Highest Citations on Nitrogen Fixation by Legumes

Bibliometric analysis for the 10 top publications with at least 1 or more citations was presented during the 43-years in Table 5. Zahran (1999) had citations with 954 on nitrogen fixation of legumes followed by Santi (2013) with 343 cited (Table 5).

Table 5. Top 10 ranking publication for citations

No	Publication	Citations
1	Zahran (1999)	954
2	Santi (2013)	343
3	Lodwig (2003)	338
4	Ledgard (1992)	328
5	Unkovıch (1994)	318
6	Carlsson (2003)	308
7	Chen (2003)	275
8	Ott (2005)	260
9	Van kessel (2000)	235
10	Roy (2020)	229

Author were grouped into 19 various clusters for the most citation. Cluster group shows the connection between cited publications. Cluster 1 included to have highest number of cited publications followed by cluster 2 (Figure 6).

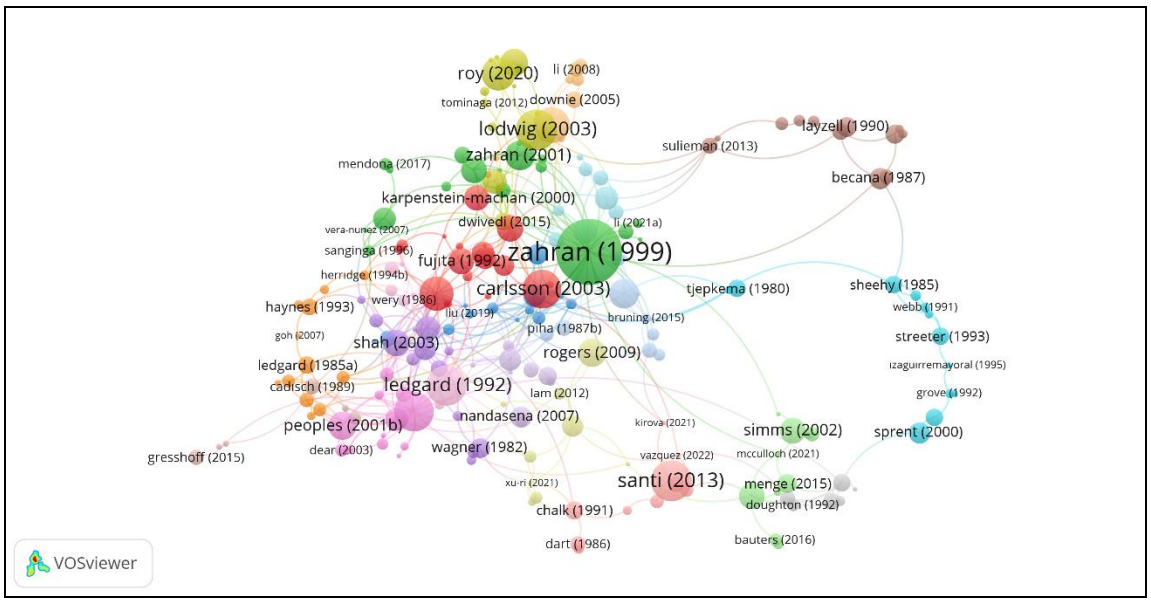

Figure 6. Bibliometric analysis map for foremost the publications with at least 1 or more Citations

Bibliographic Coupling Analysis

Bibliographic coupling analysis for the 10 top organizations with at least 1 or more publications and citations was presented during the 43-years in Figure 7. CSIRO had most citations on nitrogen fixation of legumes followed by Chinese Acad SCI (Figure 7). Organizations were grouped into 14 various clusters for the bibliographic coupling analysis. Cluster analysis shows the connection between cited organizations for bibliographic coupling. Cluster 1 included to highest number of collaboration organization with 119 for bibliographic coupling followed by cluster 2 with 60 (Figure 7). Bibliographic coupling analysis measures co-

citations in two different publications (Cevik, 2021). Bibliographic coupling is the opposite of co-citation (Al et al., 2010; Van Eck & Watman, 2014). Two publications are bibliographically coupled if there is a third publication that is cited by both publications (Kessler, 1963).

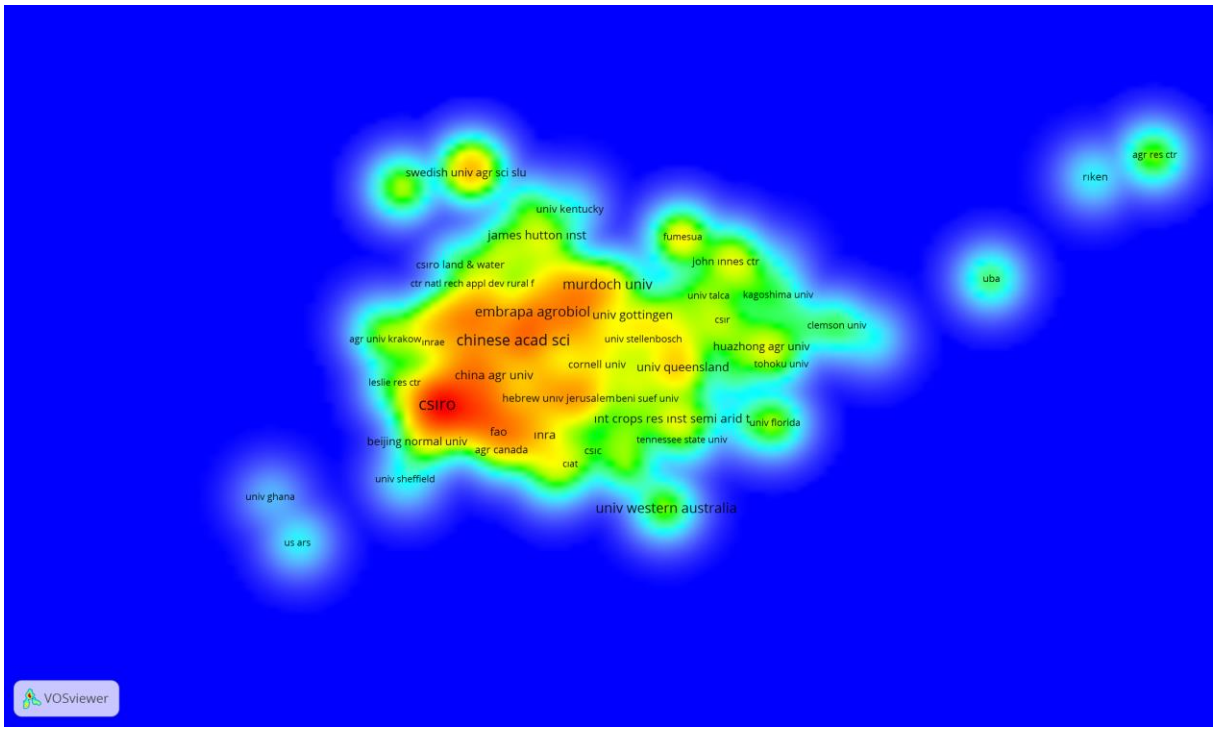

Figure 7. Bibliographic coupling analysis map for foremost organization.

Funding Agencies

Looking at the 23 year data, National Natural Science Foundad had most supporting organization on nitrogen fixation of legumes followed by National Science Foundadition Nsf (Table 6).

Table 6. Top 10 ranking organizations for funding agencies

No	Funding Agencies
1	National Natural Science Foundation Of China Nsfc
2	National Science Foundation Nsf
3	Australian Research Council
4	Grains R D Corp
5	Grants In Aid For Scientific Research Kakenhi
6	Japan Society For The Promotion Of Science
7	Ministry Of Education Culture Sports Science And Technology Japan Mext
8	Conselho Nacional De Desenvolvimento Cientifico E Tecnologico Cnpq
9	Cgiar
10	China Scholarship Council

Conclusions

In this study, 356 publications on nitrogen fixation of legumes between 1980-2023 were investigated using Web of Science (WoS) data and VOS viewer programm by bibliometric analysis methods. The highest number of publication was produced in 1987 the lowest one is in 1989. Peoples, M had highest number of publication followed by Sprent, J. The highest number of citation was achieved from year of 2021 with 1038 while the lowest was in 1980. Plant and Soil has the most record count of publications. The organization with most publications was CSIRO. Swedish University of Agricultural Sciences had 438 citations with 6 documents while CSIRO had the 400 citations with 14 documents. The publication of Zahran (1999) had highest citations on nitrogen fixation by legumes. USA and Australia had highest the numbers of publications. As a results, the

study revealed fields of research, identify the main journal, authors, countries, research trends conducted on nitrogen fixation of legumes by bibliometric analysis methods.

Scientific Ethics Declaration

The author declares that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the author.

Acknowledgements or Notes

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