Scientometric Analysis of the major *Pinus* spp. Diseases

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A B S T R A C T

The diseases are responsible, in part, for the decrease in the productivity of Brazilian commercial Pinus plantations. The present work had as objective to perform a scientometric analysis of the articles, focusing on the eight main pathogens that affect the culture of *Pinus* spp. For the development of this study, specialized searches were made on the "Web of Science" portal using as key words the scientific names of pathogens and *Pinus* spp. In the general search, a result of 1010 articles published between 2000 and 2019 was obtained, being *Bursaphelenchus xylophilus*, *Fusarium* spp. and *Sphaeropsis sapinea*, the pathogens with the highest number of published works and also of citations. As for the relation citations/article, *Phytium* spp. (mean of 70.71 citations/article) and *Sphaeropsis sapinea* (average of 18.68 citations/article). A total of 238 journals were responsible for the published works, nine of which concentrated 1/3 of the total articles.

Introduction

In Brazil, pine plantations occupy about 1.6 million hectares, mainly concentrated in the states of the southern region of the country, which have better soil and climate conditions. In 2018, Brazilled the world ranking of pine productivity, with a productivity of 30.1 $m^3.ha^{-1}.year^{-1}$, reaffirming the economic importance of culture in the forestry sector, which employs 510 thousand people and generates around U$ 8.9 billion of dollars per year (Ibá, 2019).

However, diseases are responsible, in part, for the decrease in the productivity of Brazilian commercial plantations. Among the incident pathogens, the nematode *Bursaphelenchus xylophilus* is an invasive species responsible for the development of pine wilt disease, and

is recognized worldwide as one of the main forest pests, mainly due to the difficulty of eradication (Cardoso *et al.,* 2016). Root rot disease can be caused by soil pathogens *Fusarium* spp., *Phytophthora* spp., *Pythium* spp., *Rhizoctonia solani* and *Cylindrocladium* spp (Auer and Santos, 2016).

Within this complex of pathogens, the fungus *Fusarium* sp. for being considered a cosmopolitan pathogen, causing significant losses in the pine, mainly in nurseries. The great difficulty in eradication is due to transmission via seed (Silva *et al.,* 2017). Likewise, the fungus *Phytophthora* spp. can cause seedlings to fall and leaf lesions (Rolando *et al.,* 2017). *Pythium* spp. and *R. solani* occur mainly during the seedling production phase, due to the contamination of the soil and the material used, however, their incidence in the nurseries is low and scarce (Auer and Santos, 2016).

In the case of root rot, caused by the fungus *Armillaria* spp. it is a constant concern in forest fields, as it causes severe attacks and causes a high percentage of mortality, especially in young trees (Mesanza *et al.,* 2017). Similarly, the fungus *Sphaeropsis sapinea* is distributed throughout all production areas, causing great damage in several pine species worldwide, causing pointer drought, occurring from the stage of seedlings in nurseries to mature trees in plantations ornamental plants, forest plantations and natural stands (Georgieva *et al.,* 2016).

Conversely, the fungus *Cylindrocladium* spp., which causes the acacia burning disease, is restricted to the northern and northeastern regions of Brazil, and the threat is not great for the crop, as intensely attacked trees recover easily (Auer and Santos, 2016).

In recent years, there has been a growing concern with monitoring scientific production, both nationally and internationally. In this sense, an information science goes beyond researching resources and processing information, but it is also measured as information properties, its history and its theories (Queiroz and Moura, 2015). In this context, scientometric studies emerged, such as the methods used to evaluate scientific production, numerical indicators and the use of statistical statistics discussed and validated in a systematic way (Vanti *et al.,* 2002; Galvão and Pereira, 2014).

In this way, a science visa identifies current patterns and trends in publications in a given field of knowledge (Ensslin *et al.,* 2015). In Brazil, science sciences have advanced in recent years, mainly due to several contributions, since it serves to track a profile of scientific fields and identify areas and branches that need more attention in the determined field of knowledge (Almeida *et al.,* 2016).

In this way, this work aims to raise articles on the eight main pathogens in the culture of *Pinus* spp. published on the ISI Web of Science platform, as well as its periodic numbers and number of citations, comprising the time interval between 2000 and 2019.

Materials and Methods

For the development of this study, specialized searches were made on the "Web of Science" portal with the following keywords: *Armillaria* spp., *Fusarium* spp., *Phytophthora* spp., *Pythium* spp., *Rhizoctonia solani*, *Cylindrocladium* spp., *Sphaeropsis sapinea*, *Bursaphelenchus xylophilus*, all added with the host name: *Pinus* spp. For each article, the following were identified: the year of publication, the publication periodical and the number of citations. Based on the data obtained, column charts were made for

comparisons: number of articles published by pathogen, the number of citations for the total number of articles published for each pathogen and the 20 journals with the highest number of published scientific articles.

Results and Discussion

In the general search, 1010 papers index in the Web of Science database were obtained. After filtering by pathogen, 336 papers about *Bursaphelenchus xylophilus* were collected; 301 about *Fusarium* spp.; 153 about *Sphaeropsis sapinea*; 83 about *Armillaria* spp.; 78 about *Phytophthora* spp.; 32 about *Rhizoctonia solani*; 20 about *Phytium* spp. and 7 about *Cylindrocladium* spp. (Figure 1).

As for citations obtained by the papers, it was found that the three pathogens with the highest number of citations were *Fusarium* spp., *Bursaphelenchus xylophilus* and *Sphaeropsis sapinea* (Figure 2). However, the pathogens that had the highest citations/paper mean number were *Phytium* spp. (mean of 70.71 citations/paper) and *Sphaeropsis sapinea* (mean of 18.68 citations/paper).

All other pathogens were less than 17 citations/paper, in which *Bursaphelenchus xylophilus* stood out for presenting the lowest number of citations/paper, which were only 11.36.

In total, 238 journals were responsible for the 1010 published papers. Among the journals with the largest number of publications, the following stand out: Forest Pathology (111 papers), Nematology (45 papers), Forests (41 papers), Forest Ecology and Management (32 papers), European Journal of Plant Pathology (25 papers) Plant Disease (23 papers), Plant Pathology (22 papers), Australasian Plant Pathology (17 papers), Plos One (16 papers), and the others less than 11 papers (Figure 3).

Bursaphelenchus xylophilus corresponded to 33% of the articles surveyed for diseases in *Pinus* spp. This greater number of articles related to the nematode in relation to the other pathogens can be explained by the fact that the nematode *B. xylophilus* causes one of the main diseases of the culture being disseminated in the main areas of world production, such as North America, and forbe difficult to eradicate, using insects of the genus *Monochamus* sp., which increases the number of studies related to the dynamics of the disease (Inacio *et al.,* 2015; Cardoso *et al.,* 2016).

Similarly, *Fusarium* spp. and *S. sapinea* are among the main responsible for productivity losses of pine trees, mainly because they are pathogens present in the soil and are disseminated via seed (Silva *et al.,* 2017), which can be explained by the higher average ratio of number of citations / article. Conversely, the pathogen *Cylindrocladium* was the least researched.

A possible explanation for this fact is that the study of this fungus in the culture of *Pinus* spp.it is recent and little undertaken, possibly due to the localized occurrence (Auer and Santos, 2016).

The fact that the damage that this pathogen can cause in production, tends to increase the number of studies with the pathogen, both in the number of publications and in the number of citations as well. So, in summary, as *B. xylophilus* is the pathogen with the highest number of published articles, it was naturally expected that it would have the highest total number of citations.
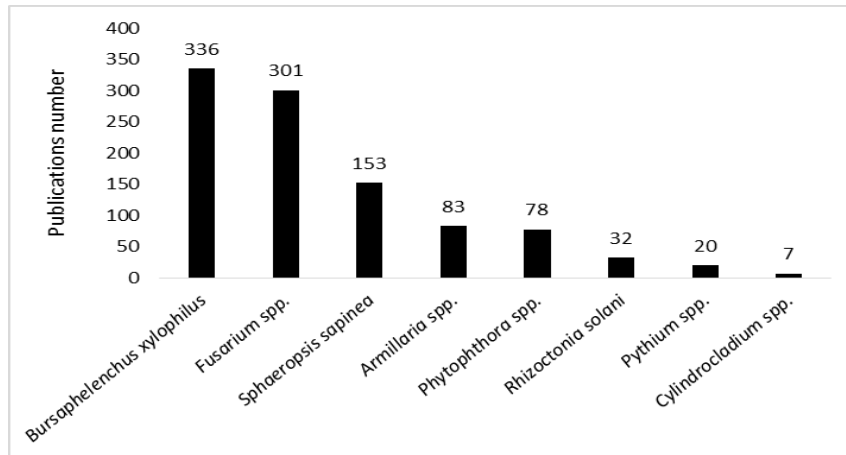
Figure.1 Number of papers about diseases in *Pinus* spp. published in the Web of Science database, covering the interval between 2000 and 2019
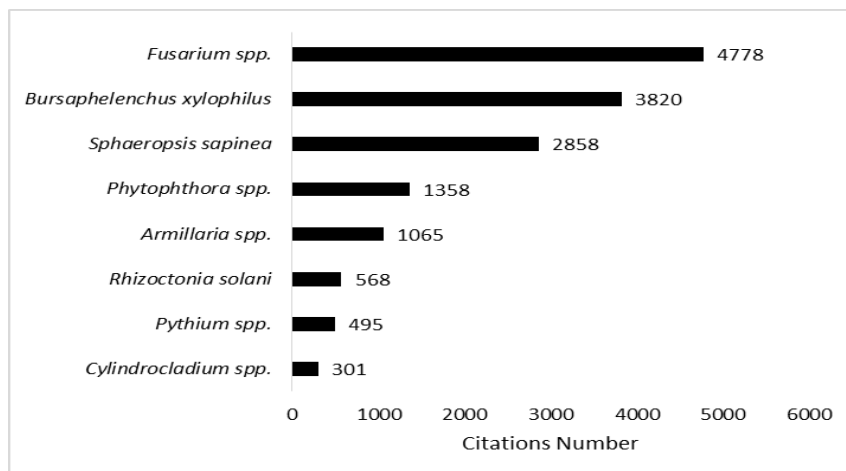

Figure.2 Number of citations obtained by articles published for each pathogen occurring in *Pinus* spp., According to a survey in the Web of Science database, covering the interval between 2000 and 2019
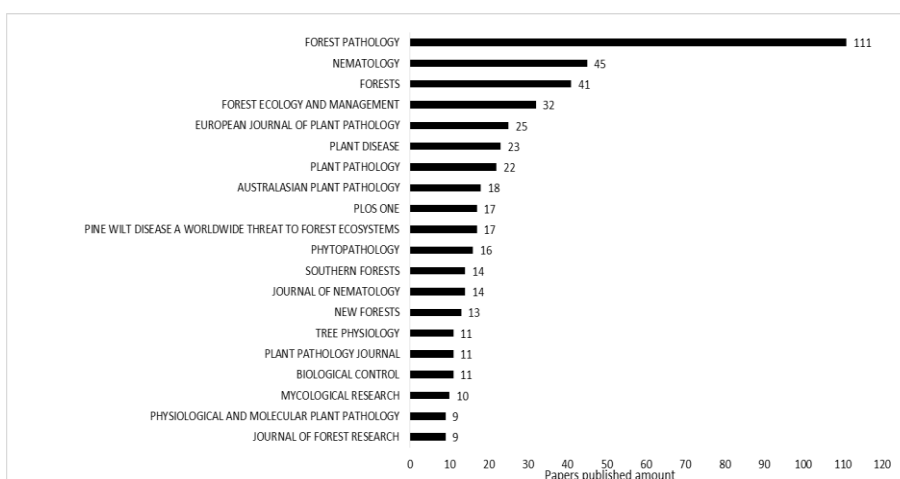

Figure.3 Journals that most published on diseases in *Pinus* spp., according to a data survey in the Web of Science, covering the interval between 2000 and 2019

However, the pathogens that had the highest average number of citations / article were *Cylindrocladium* spp. and *Phytophthora* spp.A higher ratio of average number of citations / articles in the case of *Phytium* spp. was already expected, since, according to Auer and Santos (2016), this fungus genus is the causative agent of diseases important in *Pinus* spp.

A total of eight journals concentrate 1/3 of the total published articles on pine diseases. However, the journals Forest Pathology, Nematology, Forests, Forest Ecology and Management, Plant Pathology, Plant Disease and European Journal of Plant Pathology deserve to be highlighted, since together they concentrate more than 30% of the articles in the total, a fact that can be explained by the group of journals in its scope the pathology of forest species.

The pathogen with the highest number of articles published in the culture of *Pinus* spp. is *Bursaphelenchus xylophilus*, while the pathogen with the highest average ratio of citations / scientific article is *Phytium* spp. Only nine journals concentrate 1/3 of the total number of articles published on diseases of *Pinus* spp.

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References

Almeida, L.M., C.A. Nogueira,P.P. Borges, A.D.L. Prado and Gonçalves, P.J.2016.State of the art of scientific literature on *Hancorniaspeciosa*: Trends and gaps. Revista Brasileira de Fruticultura. 38(4): 1-10.

Auer, C.G., and Santos. A.F.2016. Doenças dos Pinheiros. In: Manual de Fitopatologia: Doenças das plantas cultivadas (5 ed.) Kimati, H.,L. Amorim, J.A.M. Rezende, A. Bergamin Filho and Camargo, L.E.A.Agronômica Ceres,Ouro Fino. 2, Pp.595-602.

Bakkalbasi, N.,K.Bauer, J.Glover and Wang, L. 2006. Three options for citation tracking: Google Scholar, Scopus and Web of Science. Biomedical Digital Libraries**.**3(7): 1-8.

Bufrem, L.,and Prates, Y. 2005.O saber científico registrado e as práticas de mensuração da informação. Ciência da Informação. 34(2): 9-25.

Cardoso, J.M.S.,S.I.Anjo, L. Fonseca, C. Egas, B. Manadasand Abrantes, I. 2016. *Bursaphelenchus xylophilus* and *B. mucronatus* secretomes: a comparative proteomic analysis. Scientific Reports.6(1): 1-12.

Coutinho, V.M.,A.P.D Corte, C.R. Sanquetta, A.M.K. Hentz, R.L.Eisfeld and Nascimento, F.A.F. 2017. Mapeamento das áreas plantadas com *Eucalyptus* spp. no Estado do Paraná. BIOFIX Scientific Journal.2(1): 32-43.

Ensslin, L.,C. Waiczyk,L.C. Chaves andEnsslin, E.R. 2015. The process of evidencing the state of the art in scientific production management. TransInformação. 27(3): 220-228.

Falagas, M. E., E. I. Pitsouni, G. A. MalietzisandPappas, G. 2008. Comparison of PubMed, Scopus, web of science, and Google scholar: strengths and weaknesses. The FASEB Journal. 22(2): 338-342.

Ferreira, S.M.,C. Petrauski,G. M. Marques, M. L. Silva, S. A. Cordeiro and Soares, N. S. 2012. Competitividade do Brasil

no mercado internacional de madeira serrada. Cerne. 18 (1): 99-104.

Galvão, T. F., andPereira, M. G. 2014. Revisões sistemáticas da literatura: passos para sua elaboração. Epidemiologia e Serviços de Saúde. 23(1): 183-184.

Georgieva, M.I., andHlebarska, S. 2017.A review of *Sphaeropsis sapinea* occurrence on *Pinus* species in Bulgaria. Journal of BioScience and Biotechnology. 5(3): 247-250.

IBÁ – Indústria Brasileira de Árvores. 2019.Anuário Estatístico IBÁ 2019. Brasília.80p.

Inacio, M.L.,F. Nobrega, P. Vieira, L.Bonifacio, P. Naves, E. Sousaand Mota, M. 2015.First detection of *Bursaphelenchus xylophilus* associated with *Pinus nigra* in Portugal and in Europe. Forest Pathology. 45(1): 235–238.

Mesanza, N., C.L Patten andIturritxa, E. 2017. Distribution and Characterization of *Armillaria* Complex in Atlantic Forest Ecosystems of Spain. Forests. 8(7): 235.

Miranda, L. B. 2016. Custos Florestais: Implantação de um sistema de custeio em uma propriedade rural, tendo como enfoque o controle dos custos incorridos em uma plantação de *Pinus Taeda*, situada na zona rural, da cidade de Sengés, estado do Paraná.Redeca. 3(2): 110-129.

Queiroz, D. G. C., and Moura, A. M. M. 2015. Ciência da Informação: história, conceitos e características. EmQuestão. 21(3): 26-42.

Rolando, C.A., M.A. Dick, J.Gardner,M.K.F. Bader and Williams, N.M. 2017. Chemical control of two *Phytophthora* species infecting the canopy of Monterey pine (*Pinus radiata*). Forest Pathology. 47(3): 1-10.

Silva, T.W.R.,Á.F. Santos, C.G. Auerand Tessmann, D.J. 2017. Métodos de detecção, transmissão e patogenicidade de *Fusarium*spp. em sementes de *Pinus Taeda*. Ciência Florestal**.** 27(1):73-84.

Strehl, L., and Santos, C.A. 2002.Indicadores de qualidade da atividade científica. Ciência Hoje. 31(186): 34-39.

Vanti, N.A.P. 2002. Da bibliometria à webometria: uma exploração conceitual dos mecanismos utilizados para medir o registro da informação e a difusão do conhecimento. Ciência da Informação. 31(2): 152-162.

Vasques, A.G., A.S Nogueira, F.F. Kirchner andBerger, R. 2007.Uma síntese da contribuição do gênero *Pinus* para o desenvolvimento sustentável no sul do Brasil. Floresta. 37(3): 445-450.