Research Article

A Review on Research Trend on Sigatoka Diseases from 1965 -2018: Bibliometric Approach

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ABSTRACT

Sigatoka is major disease in banana and plantain production globally. The objective of this study is to analyze the trend at which sigatoka diseases is going, based on that, several components were retrieved from Scopus database during the period of 1961 – 2018. Specific keywords that contained "sigatoka" and "mycosphaerella "were formulated to retrieve relevant documents from the Scopus database. A total of 256 documents were analyzed. This component included most prolific authors, country productivity in sigatoka disease, keyword, document types and source type and citations from publications were also analyzed. Leading institutions also determined based on their volume of publications in black sigatoka disease. Brazil had the highest number of publication with 54 and 320 citations, followed by United State with 39 publications, 669 citations. Nigeria is the only Africa country among the Top 10 countries in black sigatoka disease research during the period of this study. The most productive author is Ortíz, Rodomiro with 12 publications (328 citations). Consequently, CIRAD Centre de Recherche de Montpellier is the most productive affiliation/ institution with a number of 21 documents published. 2009 and 2016 are the most productive year in this subject domain since 1961. Acta Horticulturae is the leading source outlet used by black sigatoka disease researcher with 21 documents published and 79 citations. A total of 252 authors contributed to sigatoka disease 1961. This study reveals research gaps in black sigatoka disease. Also, provide platform for standard research work. Sigatoka is major disease in banana and plantain production globally.

Keyword: Sigatoka Disease, Mycosphaerella, Banana, Bibliometric; Fungi, Research Trend

1. INTRODUCTION

Banana (Musa spp.) belongs to the family Musaceae. It is probably the world's oldest grown plants (Kumar et al., 2012). Banana is a vital fruit crop of the tropical and subtropical regions of the world which is a good source of starch, sugar and minerals, particularly potassium, calcium, sodium and magnesium (Doymaz et al 2019). Also, according to Danso et al. (2006) chromium (Cr), zinc (Zn), selenium (Se), iron (Fe), cobalt (Co), manganese (Mn), and copper (Cu) are present in banana and plantain and these seven micronutrients are very essential to human life. Furthermore, CTA (2005) reported that banana are important source of revenue and alleviate many small scale farmers from poverty.

Based on the gross value of production of agricultural crops, rice, wheat, maize are the most important food crop, making banana is the fourth most global food product (Shaibu, Maji and Ogburia, 2012). With an annual yield estimated at 100 million tonnes (Mohapatra et al., 2010). The leading producing countries are India and China (FAO (2019); Randy 2015).

In Africa, the major producers of banana are Uganda followed by Rwanda, Ghana, Nigeria, and Cameroon (IITA 2019). Optimum production of banana is constrained by both abiotic and biotic factors were Pests and diseases have been identified as the major biotic factors limiting banana and Plantain production, Also The major diseases of banana include, Banana bract mosaic virus, Banana streak virus, Stem-end rot, Panama wilt and Sigatoka disease 'Mycosphaerella spp' which is a major constraint of banana production (Mendoza-Rodríguez et al., 2018; (Tushemereirwe, 1996).

The disease was first observed in the Sigatoka district, Fiji, in 1963 (Rhodes, 1964) hence the name. Subsequently, black Sigatoka was observed in Honduras in 1972 (Mourichon and Fullerton, 1990) and in southern Mexico and Central America (Stover, 1980; 1983) between 1977 and 1980. In Africa, the disease was first observed in Zambia in 1973 and Gabon in 1978 (Gauhl et al., 2000). Black Sigatoka later spread to surrounding countries and it was observed in the Democratic Republic of Congo in 1988 (Mobambo and Naku, 1993). In East Africa, the disease was first observed in Burundi and Rwanda in 1986 (Sebasigari and Stover, 1988); then in 1990 the disease was reported in Uganda (Tushemereirwe and Waller, 1993).

The low banana yields have been due to a number of factors, including pests (banana weevils and banana nematodes), drought, poor soils, and diseases such as Banana Bunchy Top Virus (BBTV) , Fusarium wilt,

burrowing nematode Radopholus similis , banana bacterial wilt, black Sigatoka , Colletotrichum musae, Banana Streak Virus ,(Gold et al., 1994; Churchill 2011; Blomme et al. 2011. Tushemereirwe et al., 2003; Ploetz et al. 2015; Wong et al. 2012).

Black Sigatoka has been reported to cause a yield loss of up to 37% on bananas in Uganda (Tushemereirwe, 1996).

There are three major type of sigatoka leaf disease affecting Musa species family (banana/ plantain). Mycosphaerella musicola (yellow sigatoka), Mycosphaerella Fijiensis (Black Sigatoka) and Mycosphaerella eumusae (eumusae leaf spot) (Carlier et al. 2000; Jones 2000; Ploetz, 1998, Crous and Mourichon 2002).

In tropical coastal regions, sigatoka disease is currently increasing in a rapid rate (Stover 1972; Carlier et al. 1994; Jones 2000). Furthermore, In Nigeria, South East and Mauritius M. eumusae has been detected and will be widely spread due to its similarity with M. musicola and M. fijiensis (Carlier et al. 2000).

There has been one failed intervention to address the problem of black Sigatoka. As a medium term intervention against reduced yields, disease resistant materials were accessed from international breeding programmes and given to farmers particularly those in central Uganda (Nowakunda et al., 2000; Rutherford and Gowen, 2003; Nowakunda and Tushemereirwe, 2004).

Based on literature importance to show the relevance of key issues and impact related of black sigatoka research, hence, literature related in this area is difficult to find and there are scanty and not up-to-date bibliometric studies on black sigatoka research. With the help of bibliometric techniques the trend and growth of intellectual information is been review to the researchers (Coursaris et al., 2014; McBurney et al 2002). A research report by Luis Perez Vicente in 2013 reveals that there are relationship between rainfall and the speed of sigatoka disease evolution in Latin America/Caribbean such as Cuba, Costa Rica and Ecuador. In contrast, strict measures should be taken during rainy seasons to eliminate the inoculum of the disease (Orozco-Santos et al. 2002) and so reduce epidemic effects.

Bibliometric techniques used in this study is a mathematical application and statistical method in quantifying the general perception of black sigatoka disease domain in such a way that the volume and impact of scientific publications is been measured. Also, serve as insight into formulation of research policies of sigatoka disease domain. Furthermore, it enable scholars to identify pattern of publication, prolific authors, top affiliation, year trend, citation trend, document types, productive source outlet over a period of time (Omotola et al 2019).

Understanding the perspective of sigatoka disease research which forms a basis to identify influential and productive scholars, determine research cavities and prospects, and discover areas that are less explored by researchers that focuses in the subject domain. Therefore, the outcome of this study would, in turn, contribute to forming research agendas, guidelines and standards (Serenko et al 2008; Omotola et al 2019).

For the purpose to achieve the aim of this study the following research objectives were formulated to determine the yearly distribution of black sigatoka publications for 1965-2018, country contributions on sigatoka disease domain based on volume of academic publications, identifying the prolific authors and their affiliations/ institutions, productive institutions contributing to black sigatoka research domain, outline the source outlets of black sigatoka research works, most productive documents types and citation trends of black sigatoka research be published during the period of this study (Yearly and Cited publications) and identifying the keyword trend of sigatoka disease researcher

2. METHODOLOGY

To achieve the aim and objective of this study, Scopus database was used as source to extract the data. Scopus has the largest database with 39,000 published academic documents with abstract and citations, journal, book, conferences proceedings and peer- reviewers (Elsevier, 2017, 2019). Specific keywords that contained “sigatoka” and “mycosphaerella “was designed to extract relevant documents data from the Scopus database. The search query used is framed thus: TITLE-ABS-KEY (* sigatoka * and * mycosphaerella *) excluding the year 2019 from the search query due to incomplete record as when the search query was done (May 15, 2019, 5: 35PM). The asterisk symbol (*) was used as a wildcard to take into account all variation of the term to be returned in the indexed results.

In this study, a total of 256 publications met the search query criteria analysis from the Scopus database. Retrieved documents from Scopus comprises of the productive Author, Citation count, Source title, Institutional Affiliation, Documents Type, subject area, country, keyword, Author Frequency.

Command Separated Version (CSV) file format were used to export the retrieved document to MS Excel application which enable us to analysis the extracted data to unveil the trend of black sigatoka research domain during the period of this study.

3. RESULT S

a. Yearly Distribution

There has been increase and decrease in publications since 1961 for example only 13 (5.1%) publication was observed and later decline to 11 (4.3%) publication in 2008. Furthermore, there was an exponential increased in 2009 with 22 (8.6 %) publications. Making 2009 and 2016 the most productive year with 22 (8.6 %) publications respectively. However, downward publication was observed in 2017 (3.1%) and 2018 (3.5%) compared to 2016. Also, this study has revealed that there is no steady growth of publication recently in sigatoka diseases. Only one (1) publication titled "Significance of the anti-sporulation effect of copper fungicides in the control of sigatoka disease of bananas caused by mycosphærella musicola leach" author by Evan and whitaker was published in 1961 based on scopus database (Evan et al. 1961). It was observed that in some year no publication was carried out (1963-1965, 1977 – 1981, 1988, 1986, 1985,) see table 1.

Table 1: Yearly Distribution of Sigatoka Disease since 1961 -2018

b. Country Distribution

From the data retrieved from Scopus database, about 50 countries had published at least one intellectual publication sigatoka disease as showed in Table 2: In this study the top 10 countries in sigatoka disease were analysis. Analysis revealed that Brazil has the highest number is publication in sigatoka disease with 54 (13.2%). However, country like United State with (39 publications) had the highest number of document cited with 669 citations. It was also observed that United State and France h-index were higher than other countries in sigatoka disease with 14 h- index respectively. This study also reveals that South America (Brazil) and North America (United State) was the leading continent in sigatoka disease followed by Africa (Nigeria) with 26 documents, these was followed by Europe (France) with 25 (6.1 %) documents, 469 citations and 14 h- index. Netherland came 10th in sigatoka disease with 17 publications since during the period of the research.

Table 2: Top 10 Most Prolific Country and Their Citations and h- Index

c. Most Prolific Author in Sigatoka Disease

In this study, the top 13 most productive authors and their affiliation, coupled with their citation and h- index of their research documents in sigatoka disease during the period of 1961 – 2018. The most productive author in sigatoka disease is Ortíz, Rodomiro from Sveriges lantbruksuniversitet, Department of Plant Breeding, Uppsala, Sweden with a total of 12 (4.7%) publication and also having the number of citations and h- index of 328 and 25 respectively. This was accompany by Carlier, Jean from CIRAD Centre de Recherche de Montpellier, Montpellier, France with 11 (4.3%) documents, 241 citations and 9 h- index in sigatoka disease during the period of this study. Abadie, Catherine from CIRAD, Paris, France and Vuylsteke, Dirk R from International Institute of Tropical Agriculture (IITA), Ibadan, Ibadan, Nigeria followed with 10 publications (3.9 %) and 9 publication (3.5%) publication respectively. Based on the analysis in from the database (Scopus), it was observed that out of the 13 most productive author's 6 (six) of the author's affiliation are from Brazil and France while the remaining are from Netherlands, Nigeria, Senegal, Costa Rica, Austria and Sweden as showed in Table 3.

Table 3: Top 13 Most Productive Authors and Their Affiliations / Institution

d. Top 15 Most Productive Institutions

In Fig 1 the analysis shows the most productive affiliation/ institution in relation to the number of documents research published in the field of sigatoka diseases. The data reveals that CIRAD Centre de Recherche de Montpellier is the most productive affiliation/ institution with a number of 21 documents published on the subject domain of this study. Secondly, Empresa Brasileira de Pesquisa Agropecuária – Embrapa having 18 research publications, this was followed by International Institute of Tropical Agriculture IITA, Ibadan and CIRAD with 17 publication each in sigatoka diseases since 1961. Furthermore, it was observed that out the 13 most productive affiliation / institution of sigatoka disease, four of the institutions were in Brazil followed by France with three institution and Mexico with 2 institutions.

Fig 1: Top 15 Most Productive Institution

e. Source Outlets

Present the top 11 most prolific source outlet from Scopus database in the field of sigatoka diseases. The leading source outlet is Acta Horticulturae with 21 published documents in sigatoka disease, that had be cited 79 times with h – index 4, these was followed by Fruit with 13 publication, 96 citations and 5 h – index. However, Crop Protection (h – index 7) and Plant Disease (h – index 6) came third and fourth with 11 publications, 117 and 118 citations respectively. It was also observed in the (Table 4) that Phytopathology had the highest number of citied

documents with a total number of 157 citations in 5 publications (h- index 5) see Table 4.

Table 4: Most productive Source Outlets

f. Document Type

Document type was explored to identify the most productive types of document published between 1961 and 2018 as showed in (Table 5). The document types were categorized as follows: The largest document type was observed in Table 5 is article with a total publication of 221 (86.6 %). Second largest were conference paper with 17 documents (6.6 %). Consequently, book chapter, Review, were observed to have (7 documents with 2.7 %), (5 documents with 2.0 %). Also, Note and short survey had (3 documents with 1.2 %) respectively in sigatoka disease.

Table 5: Productive Document Types

g. Author Frequency

A total of 252 authors have published in sigatoka disease since 1961 to 2018 with 256 publications. Analysis has reveal that five authors had the highest number of publication, followed by four and three authors with 41 publications respectively each. There was a significant downward flow publication when the authors were increase twelve and above. Single and two authors produce 15 and 29 publications respectively. Based on the (Table 6), it is more convenient for three to six authors to carry out a research in sigatoka disease.

Table 6 Author Frequency

h. Citation Analysis:

From this study, a total of 2813 citations were observed in the 256 documents retrieved from Scopus database between 1961 to 2018 of intellectual publications in sigatoka disease. This was followed with document h-index: 25. Under the citation analysis several factors which consider as follow: yearly citation trend and most prolific publications cited in sigatoka disease during the period of study.

i. Yearly Citation Trends:

In this analysis as showed in Table 7. The last ten years were chooses due to the high number of citation observed with 74.7% of the total citation of the 256 documents published. Yearly citations of the 256 document were analyzed. The last past 10 years between 2009 to 2018 reveals that the most prolific year in terms of citation was 2016 with 297 (10.6 %) citations. Also, 2018 was the second largest with 262 citations, followed by 2011 and 2013 had the same number of citations and percentage (229) as showed in table7. Furthermore, in 2009, 2010 and 2011 there was an increase in citations from 128(4.6%), 133(4.7%) and 229(8.1%) citations respectively. However, decrease in number of citation was observed in 2012 (7.2%).

Table 7: Yearly Citation Trends

j. Top I5 Cited Publications

The top 15 most cited document among the 256 document retrieved from Scopus database in the research area of sigatoka disease were also analysis. Based on the result, the most cited publication is titled "Mode of resistance to respiration inhibitors at the cytochrome bc enzyme complex of Mycosphaerella fijiensis field isolates" with 118 citations and was authored by Sierotzki, H., Parisi, S., Steinfeld, U., Tenzer, I., Poirey, S., Gisi, U. The purpose of the study is for Field isolates of Mycosphaerella fijiensis, which causes black Sigatoka of banana, by characterizing their sensitivity to different inhibitors of the cytochrome bc 1 enzyme complex (Qo respiration inhibitors, strobilurin fungicides), using physiological, biochemical and molecular generic methods (Sierotzki et al 2000). Also, "Tomato Cf resistance proteins mediate recognition of cognate homologous effectors from fungi pathogenic on dicots and monocots "which had 95 citation (Stergiopoulos et al 2010). Several publications such as Development and performance of balck sigatoka-resistant tetraploid hybrids of plantain (Musa spp., AAB group (Vuylsteke, et al 1992) and Development and performance of balck sigatoka-resistant tetraploid hybrids of plantain (Musa spp., AAB group) had 86 and 83 citations respectively during the period of this study(Mitchell et al 2010) as showed in table 8.

Table 8: Top I5 Cited Publications

k. Keyword Trend

Several keyword related to sigatoka disease were also retrieved from Scopus since 1961. These are the major keywords used by authors in sigatoka diseases. The top 10 keywords as showed the table 9: the leading keyword is Mycosphaerella Fijiensis with had appeared in 160 times, followed by Musa 103 times. Banana, Mycosphaerella Muscola and Black sigatoka had 67, 61, 60 appearances.

Table 9: Top 10 Keywords Trend

4. CONCLUSION

The findings from this bibliometric study reveals that only 256 research publication have been done in sigatoka disease. Several components were analysis such as follows: the most prolific authors and their affiliations were identified Ortíz, Rodomiro from Sveriges lantbruksuniversitet, department of Plant Breeding, Uppsala, Sweden with 12 publications, 328 citation and 25 h- index. Furthermore, Document types, source outlet and keyword trend was analysis. Countries like Brazil, United State, Nigeria, France and United Kingdom were the leading countries among other like Colombia and Mexico. Hence, a bibliometric analysis was carried by (Adejoro et al 2013), showing the disease and pest incidence of musa spp in Africa, result reveal that West Africa countries such as (Nigeria, Cameroun, Ghana, Benin Republic, Gambia, Cote d'Ivoire,) and Uganda are highly infected by Mycospharella spp. Furthermore, more research activities are required in this Africa region.

In this study, Citation analysis was also performed to ascertain the total number of publications in sigatoka disease cited and yearly citations. Furthermore, Author frequency which shows that three to six author had the highest number of publication. In 2009 and 2016 the highest of documents published. It was observed that in some year no publication was carried out (1963-1965, 1977 – 1981, 1988, 1986, and 1985).

5. SIGNIFICANCE STATEMENT

Based on this study, several researchers will understand and identify the gap in sigatoka disease and furthermore, provide a guild line in which researcher is to publish their document and identify topics been less researched upon. Consequently, this study shows the research trend of sigatoka disease globally. Also encourages more erudite scholars to venture into the sigatoka disease research. Also, countries with high annual rainfall should engage in more research activities on sigatoka disease.

6. CONFLICT OF INTEREST

The authors have no conflict of interest

7. AUTHORS' CONTRIBUTIONS

Erere Avwerosuo, did the literature search and wrote the first draft of the manuscript. Joseph Abiodun, Alori Elizabeth, Aremu Charity and Abolusoro Stephen supervised and contributed to the writing of the final version of the manuscript. All authors approved of the final version of the manuscript

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In this research work, there is no conflict of interest.

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10. TABLES AND FIGURE

Figure 1: Top 15 Most Productive Institution

Table 1. Yearly Distribution of Sigatoka Disease since 1961 -2018

Table 2. Most Prolific Country and Their Citations and h- Index

Table 3. Most Productive Authors and Their Affiliations / Institution

Table 4. Most productive Source Outlets

Table 5. Productive Document Types

Table 6. Author Frequency

Table 7. Yearly Citation Trends

Table 8. Top I5 Cited Publications

Table 9. Top 10 Keywords Trend

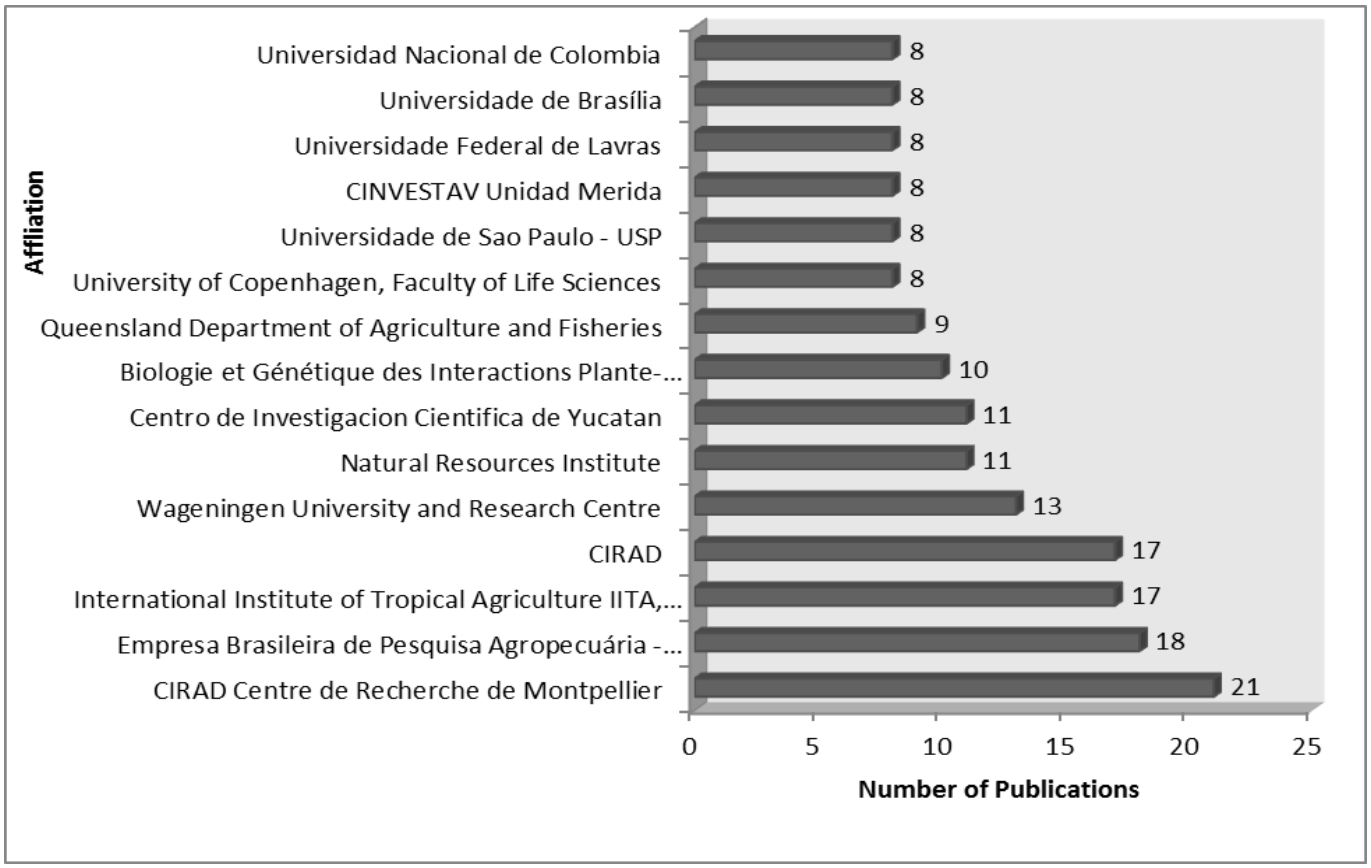

Fig 1: Top 15 Most Productive Institution

Table 1: Yearly Distribution of Sigatoka Disease since 1961 -2018

	Year	No of Publications	Percentage
1	2018	9	3.5
2	2017	8	3.1
3	2016	22	8.6
4	2015	13	5.1
5	2014	12	4.7
6	2013	18	7.0
7	2012	16	6.3
8	2011	12	4.7
9	2010	9	3.5
10	2009	22	8.6
11	2008	11	4.3
12	2007	13	5.1
13	2006	6	2.3
14	2005	4	1.6
15	2004	3	1.2

16	2003	6	2.3
17	2002	3	1.2
18	2001	4	1.6
19	2000	6	2.3
20	1999	3	1.2
21	1998	14	5.5
22	1997	9	3.5
23	1996	5	2.0
24	1995	5	2.0
25	1994	4	1.6
26	1993	3	1.2
27	1992	4	1.6
28	1991	2	0.8
29	1990	2	0.8
30	1987	1	0.4
31	1984	1	0.4
32	1983	1	0.4
33	1982	1	0.4
34	1976	1	0.4
35	1965	1	0.4
36	1962	1	0.4
37	1961	1	0.4

Table 2: Top 10 Most Prolific Country and Their Citations and h- Index

	Country	No of Publications	Percentage	Citation	h-index
1	Brazil	54	13.2	320	11
2	United States	39	9.5	669	14
3	Nigeria	26	6.3	421	11
4	France	25	6.1	469	14
5	United Kingdom	24	5.9	290	11
6	Mexico	20	4.9	131	7
7	Colombia	18	4.4	168	8
8	Costa Rica	17	4.1	221	8
9	Australia	16	3.9	163	8
10	Netherlands	15	3.7	345	9

Table 3: Top 13 Most Productive Authors and Their Affiliations / Institution

	Author	Affiliations / Institution	No of Publication	Percentage	Citations	H - Index
1	Ortíz, Rodomiro	Sveriges lantbruksuniversitet, Department of Plant Breeding, Uppsala, Sweden	12	4.7	328	25
2	Carlier, Jean	CIRAD Centre de Recherche de Montpellier, Montpellier, France	11	4.3	241	9
3	Abadie, Catherine	CIRAD, Paris, France	10	3.9	129	5
4	Vuylsteke, Dirk R.	International Institute of Tropical Agriculture (IITA), Ibadan, Ibadan, Nigeria	9	3.5	219	8
5	Kema, Gerrit H.J.	Wageningen University and Research Centre, Wageningen Plant Research, Wageningen, Netherlands	8	3.1	204	4
6	Miller, Robert N.G.	Universidade de Brasília, Departamento de Biologia Celular, Brasilia, Brazil	8	3.1	42	3
7	Chillet, Marc	CIRAD, Paris, France	7	2.7	54	3
8	Crous, Pedro Willem	Westerdijk Fungal Biodiversity Institute, Utrecht, Netherlands	7	2.7	194	6
9	Tenkouano, Abdou	CORAF/WECARD, Dakar, Senegal	7	2.7	75	5
10	Emediato, Flavia L.	Universidade de Brasília, Brasilia, Brazil	6	2.3	36	2
11	Gasparotto, Luadir	Empresa Brasileira de Pesquisa Agropecuária - Embrapa, Brasilia, Brazil	6	2.3	34	3
12	Gauhl, Friedhelm	Chiquita Brands International, San Jose, Costa Rica	6	2.3	111	4
13	Pasberg-Gauhl, Cornelia	Xilicate GmbH, Vienna, Austria	6	2.3	111	4

Table 4: Most productive Source Outlets

	Source Title	Number of Publication	Percentage	Citation	H- Index
1	Acta Horticulturae	21	8.2	79	4
2	Fruits	13	5.1	96	5
3	Crop Protection	11	4.3	117	7
4	Plant Disease	11	4.3	118	6
5	Australasian Plant Pathology	9	3.5	52	5
6	Plant Pathology	8	3.1	100	5
7	Hortscience	7	2.7	65	5
8	Journal Of Phytopathology	6	2.3	82	5

9	Phytopathology	5	2.0	157	5
10	Tropical Pest Management	5	2.0	20	3
11	Tropical Plant Pathology	5	2.0	11	2

Table 5: Productive Document Types

	Document Type	Number of Publication	Percentage
1	Article	221	86.6
2	Conference Paper	17	6.6
3	Book Chapter	7	2.7
4	Review	5	2.0
5	Note	3	1.2
6	Short Survey	3	1.2

Table 6 Author Frequency

	Author Frequency	Number of Publications
1	Single Author	15
2	Two Authors	29
3	Three Authors	41
4	Four Authors	41
5	Five Authors	48
6	Six Authors	29
7	Seven Authors	15
8	Eight Authors	9
9	Nine Authors	13
10	Ten Authors	3
11	Eleven Authors	5
12	twelve Authors	1
13	Above Twelve Authors	3

Table 7: Yearly Citation Trends

	Year	Number of Citations	Percentage
1	2018	262	9.3
2	2017	222	7.9
3	2016	297	10.6
4	2015	213	7.6
5	2014	186	6.6
6	2013	229	8.1
7	2012	203	7.2
8	2011	229	8.1
9	2010	133	4.7
10	2009	128	4.6

Table 8: Top I5 Cited Publications

S/N	Authors Name	Publications Title	Number of Citations
1	Sierotzki, H.a, Parisi, S.b, Steinfeld, U.a, Tenzer, I.a, Poirey, S.b, Gisi, U.a,c	Mode of resistance to respiration inhibitors at the cytochrome bc enzyme complex of Mycosphaerella fijiensis field isolates	118
2	Stergiopoulos, I.a, Van Den Burg, H.A.a,b, Ökmen, B.a, Beenen, H.G.a, Van Liere, S.a, Kema, G.H.J.c, De Wit, P.J.G.M.a,b	Tomato Cf resistance proteins mediate recognition of cognate homologous effectors from fungi pathogenic on dicots and monocots	95
3	Vuylsteke, D.R., Swennen, R.L., Ortiz, R.	Development and performance of balck sigatoka-resistant tetraploid hybrids of plantain (Musa spp., AAB group)	86
4	Mitchell, A.M.a, Strobel, G.A.aEmail Author, Moore, E.b, Robison, R.b, Sears, J.c	Volatile antimicrobials from Muscodor crispans, a novel endophytic fungus	83
5	Churchill, A.C.L.	Mycosphaerella fijiensis, the black leaf streak pathogen of banana: Progress towards understanding pathogen biology and detection, disease development, and the challenges of control	78
6	Arzanlou, M.a,b, Groenewald, J.Z.a, Fullerton, R.A.c, Abeln, E.C.A.d, Carlier, J.e, Zapater, M.-F.e, Buddenhagen, I.W.f, Viljoen, A.g, Crous, P.W.a,b	Multiple gene genealogies and phenotypic characters differentiate several novel species of Mycosphaerella and related anamorphs on banana	73

7	Mobambo, K.N., Gauhl, F., Vuylsteke, D., Ortiz, R., Pasberg-Gauhl, C., Swennen, R.	Yield loss in plantain from black sigatoka leaf spot and field performance of resistant hybrids	70
8	Ortiz, R., Vuylsteke, D.	Inheritance of black sigatoka disease resistance in plantain-banana (Musa spp.) hybrids	61
9	Johanson, A., Jeger, M.J.	Use of PCR for detection of Mycosphaerella fijiensis and M. musicola, the causal agents of Sigatoka leaf spots in banana and plantain	60
10	Bakry, F. , Carreel, F., Jenny, C., Horry, J.-P.	Genetic improvement of banana	53
11	Romero, R.A.a,b Sutton, T.B.a	Sensitivity of Mycosphaerella fijiensis, causal agent of black Sigatoka of banana, to propiconazole	50
12	Arzanlou, M.a,b, Abeln, E.C.A.b, Kema, G.H.J.c, Waalwijk, C.c, Carrier, J.d, De Vries, I.c, Guzman, M.e, Crous, P.W.a,b	Molecular diagnostics for the Sigatoka disease complex of banana	49
13	Vishnevetsky, J.a, White Jr., T.L.c, Palmateer, A.J.c, Flaishman, M.a, Cohen, Y.a, Elad, Y.b, Velcheva, M.d, Hanania, U.a, Sahar, N.a, Dgani, O.a, Perl, A.a	Improved tolerance toward fungal diseases in transgenic Cavendish banana (Musa spp. AAA group) cv. Grand Nain	42
14	De Bellaire, L.D.L.a, Fouré, E.a, Abadie, C.b,c, Carlier, J.b	Black Leaf Streak Disease is challenging the banana industry	40
15	Cañas-Gutiérrez, G.P.a, Angarita-Velásquez, M.J.a, Restrepo-Flórez, J.M.a, Rodríguez, P.b, Moreno, C.X.c, Arango, R.a,c	Analysis of the CYP51 gene and encoded protein in propiconazole-resistant isolates of Mycosphaerella fijiensis	39

Table 9: Top 10 Keywords Trend

	Keywords	Number of Publications
1	Mycosphaerella Fijiensis	160
2	Musa	103
3	Banana	67
4	Mycosphaerella Musicola	61
5	Black Sigatoka	60
6	Mycosphaerella	58
7	Fungi	52
8	Article	37
9	Ascomycota	34
10	Ascomycetes	30