

Disease-Causing Agents in Cashew: A Review in a Tropical Cash Crop

Filipa Monteiro ^{1,2,*} , Maria M. Romeiras ^{1,2} , João Barnabé ^{1,2}, Silvia Catarino ^{1,3} , Dora Batista ^{1,2,4} and Mónica Sebastiana ⁵

- ¹ LEAF—Linking Landscape, Environment, Agriculture and Food, Associated Laboratory TERRA, Instituto Superior de Agronomia (ISA), Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisbon, Portugal
- ² cE3c—Centre for Ecology, Evolution and Environmental Changes & CHANGE—Global Change and Sustainability Institute, Faculty of Sciences, University of Lisbon, 1749-016 Lisbon, Portugal
- ³ Forest Research Center (CEF), Instituto Superior de Agronomia (ISA), Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisbon, Portugal
- ⁴ CIFC—Centro de Investigação das Ferrugens do Cafeeiro, Instituto Superior de Agronomia, Universidade de Lisboa, 2784-505 Oeiras, Portugal
- ⁵ BioISI—Instituto de Biosistemas e Ciências Integrativas, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisbon, Portugal
- * Correspondence: fmonteiro@isa.ulisboa.pt

Abstract: Due to the high market value of cashew nut, cashew became a significantly important cash crop in many countries. Originating from Brazil, the plant was introduced into Africa, India, and Southeast Asia and is nowadays found across most of the tropical regions. However, the diseases that threaten and compromise crop production have not yet been comprehensively documented. The aim of this study was to examine the published scientific data on cashew diseases, to identify current knowledge gaps, and to present a review of the most important diseases and pathogens affecting cashew productivity. The most described diseases are caused by fungi genera—mainly *Colletotrichum*, *Lasiodiplodia*, and *Erysiphe* (worldwide); *Cryptosporiopsis* (East Africa); and recently *Fusarium* in Tanzania. Other fungal genera (e.g., *Septoria*, *Pilgeriella*, and *Pestalotia*) may correspond to emerging local cashew diseases that have not yet expanded to other geographic regions or for which records are lacking. Gummosis (*Lasiodiplodia* spp.), which is considered the most prevalent and damaging disease of cashew, has a pantropical distribution. There is large discrepancy concerning the causal agents of cashew diseases that might be explained by the lack of proper species identification through morpho-cultural and molecular approaches. This, in turn, can easily lead to misdiagnoses that have serious negative consequences for the implementation of specific control actions. It is important to establish a standardized identification workflow that will allow a reliable identification of the disease-causing agent and to determine the occurrence and/or expansion of a given pathogen across cashew-producing regions.

Keywords: *Anacardium occidentale*; tropical regions; fungi; gummosis; anthracnose; powdery mildew; cashew diseases



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1. Introduction

Cashew (*Anacardium occidentale* L.) is a tropical evergreen tree native to Brazil [1]. It belongs to the Anacardiaceae family along with other important fruit species such as mango and pistachio [2]. Over the last three decades, cashew has gained significant economic importance as a cash crop in many countries due to the high market value of cashew nut [3,4], which represents significant revenues as a major export product. The cashew nut offers a good and healthy source of high contents of unsaturated fatty acids, proteins, dietary fiber, antioxidant vitamins, and flavonoids [5] and is widely used in the food industry.

Worldwide expansion was initiated by the Portuguese in the 16th century, introducing the plant from Brazil into the African continent and from there into India and Southeast Asia [6]. Nowadays, cashew is distributed over most of the tropical regions; the three top cashew nut (shelled) exporters are Vietnam, India, and Brazil [7]. The growing interest in this crop is illustrated by the increasing trend in cashew nut production over the last decades, presently reaching a world production of around 4.2 billion tons, which corresponds to USD 2.5 billion [7]. To meet the global market demand, cashew has been produced under an extensive regime, increasingly occupying more land but not achieving higher productivity, especially in West African countries, which account for 50% of the world's production. In these countries, cashew represents both a significant contribution to the gross domestic product and exports and an essential source of income for small-holder farmers; these make up most of the cashew producers in African countries such as Guinea-Bissau [8], Nigeria, and Mozambique [9].

Cashew is well adapted to seasonally wet and dry tropical climates and is able to grow in well-drained light textured soils with minimal inputs [10]. This tolerance of cashew trees to drought and poor soils, as well as the possibility of being intercropped with other cultures, has made their cultivation ideal for small farmers [11]. However, cashew is affected by several diseases that constrain production, representing a major threat to the economy and food safety of cashew-producing countries. Cashew orchards are typically established as a monocropping system, which favors the dissemination of diseases because monocultures tend to have a lower genetic variability that can compromise plant defense responses; in addition, the frequently close spacing between trees favors disease dissemination [8]. Fungal diseases in cashew trees are very diverse and affect all parts of the plant; these have caused significant losses mainly due to damages in the young tissues, which can lead to flower loss and death of nuts, compromising yield and nut quality [12–14]. For instance, in Nigeria, infestation with gummosis (*Lasioidiplodia* spp.) resulted in a 40–50% yield loss; recent outbreaks of *Fusarium oxysporum* in Tanzania had devastating consequences and killed the trees within a short period of time [15].

Despite the economic importance of cashew, data on the diseases that threaten and compromise crop production are scarce and have not yet been properly documented and made available. The aim of this study was to systematically review the available scientific data on cashew diseases, to identify current gaps in the literature, and to reveal the most important diseases and causal pathogens that affect its productivity by linking their distribution with that of cashew-producing regions across the world. Information on the status of cashew diseases is vital for the stakeholders to improve the cashew value chain and constitutes a baseline for the design of efficient strategies to control the spread of disease.

2. Materials and Methods

2.1. Literature Search and Dataset Construction

This systematic review was performed according to the PRISMA guidelines [16,17]. We searched three electronic databases: PubMed, Web of Science (WoS) and Google Scholar. The search was conducted on 15 April 2022 using the following set of keywords: (1) cashew AND disease; (2) cashew AND diseases* AND (bacteria* OR fungi*); and (3) first report cashew (Table S1). Database searches were restricted to titles and abstracts.

Records from the three databases were assembled, resulting in 538 references. Their titles and abstracts were submitted to a manual curation with the aim of selecting only original research studies published in scientific journals available in English and reporting data on cashew diseases. Duplicated articles between databases were removed. A first exclusion criterion was applied to articles that reported data not directly related to cashew diseases (e.g., records on human diseases caused by cashew, biotechnological applications of cashew byproducts; reports on technical aspects of cashew culture, etc.). A second criterion excluded grey literature such as conference papers, proceedings, theses, and

technical reports, as well as records without abstracts and those only found in the form of a citation, since these items are usually not subjected to peer review.

To add relevant reports that escaped the initial search (additional records identified through other sources), the abstract and full text of the remaining records were examined to identify the most representative cashew pathogenic genera reported and a more specific search was conducted in the same databases (accessed at 10 June 2022) using the keywords “cashew AND Colletotrichum OR Oidium OR Lasiodiplodia” (the most representative microorganism genera in the literature with more than 10 articles) (Table S1). In addition, the references from the selected articles were scanned for potential studies that might not have been indexed in the three databases used for the literature search. Records addressing cashew pests were excluded (third exclusion criterion). Records written in languages other than English were only kept if the abstract was in English. The PRISMA flow diagram shows the number of records in each step of the selection process (Figure 1).

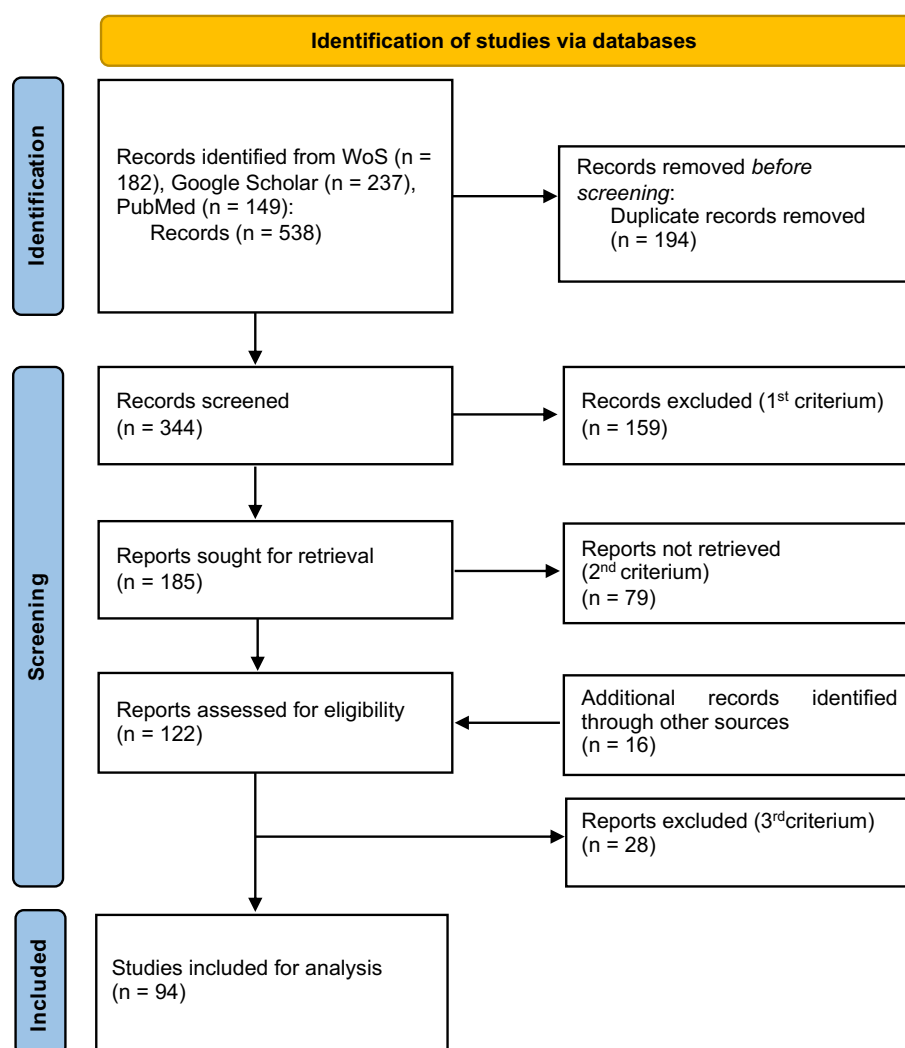


Figure 1. PRISMA flow diagram for the selection of studies included in the present systematic review on disease-causing agents in cashew studies.

2.2. Data Extraction and Analysis

The abstract and/or full text of the final records (see summarized information in Tables S2 and S3) were reviewed to extract the relevant data regarding the following aspects:

Database—database from which the article was retrieved (PubMed, WoS, or Google Scholar).

Year—year of article publication.

Country—country where data reported in each article were collected.

Microorganism group—main group of microorganisms (bacteria/fungi) to which the reported cashew pathogen(s) belong(s).

Microorganism genus—bacterial/fungal genera to which the reported cashew pathogen(s) belong(s).

Microorganism species—bacterial/fungal species to which the reported cashew pathogen(s) belong(s).

Plant tissue—Part of the cashew plant reported to be affected by the pathogen(s); the plant parts considered were: nut, apple, inflorescence, leaves, stem, trunk, and roots.

Disease-identification method—means by which the pathogen causing disease on cashew was identified; the methods considered were: disease symptoms (include the description of affected plant organs and changes in plant growth or appearance observed in field surveys), morpho-cultural characteristics (including assessments comprising shape, size, color of fungal colony, and mycelial growth rate for pathogen identification), and molecular analysis (identification of the pathogen using markers described for species-level identification).

Disease incidence/severity—disease incidence or disease severity index.

Pathogenicity tests—studies that performed pathogenicity tests (inoculation of pathogen pure isolates on cashew plants, observation of symptom development, and re-isolation of the pathogen from symptoms).

First report—first reports of cashew diseases.

The taxonomy of the microorganisms (genus and species) cited in each report were checked and updated using the NCBI taxonomy browser (<https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi> (accessed on 12 May 2022) and the GBIF Tools catalogue (<https://www.gbif.org/resource/search?contentType=tool> (accessed on 12 May 2022)). The extracted data were qualitatively analyzed to describe the status of the current scientific knowledge on cashew diseases, including the evolution of scientific research on the subject, identification of the major taxonomic groups of pathogenic microorganisms affecting cashew culture, identification of the major cashew disease geographic hotspots and their associated pathogens, identification of the plant parts affected by those pathogens, assessment of the use of molecular methods to identify pathogens in cashew against traditional methods relying on observed symptoms and on morphological and cultural characteristics, and evaluation of the incidence of the most important cashew pathogens, among others.

Chord diagrams showing the relations between the genera and factors such as the countries where the studies were performed and the plant parts affected were performed in R v. 4.0.5 [18] using the package “circlize” v. 0.4.14 and the function “chordDiagram”. The QGIS software [19] was applied to analyze the location of studies worldwide and to build their distribution map.

3. Results and Discussion

3.1. Dataset and General Results

3.1.1. Available Studies

A total of 538 records (raw data available at Figshare [20]) were retrieved from the three freely available electronic databases used in the present search—PubMed, WoS, and Google Scholar (Figure 1). After removing all the records that did not meet the established criteria (see Section 2.1), 106 records were used for further analysis. A set of 16 records was added that corresponded to studies that addressed the most important fungal genera found to cause disease in cashew (*Lasiodiplodia*, *Erysiphe*, and *Colletotrichum*). The 122 records were then screened to exclude studies on insect pests, non-English-written studies, and review articles. Finally, a total of 94 records fitting all our inclusion criteria were used as sources of the data for the present review.

A Venn diagram (Figure S1) showed that Google Scholar was the main source of records, followed by WoS. A high overlap of the records obtained from PubMed and the other databases was detected, with no unique records retrieved from PubMed.

According to the year of publication (Figure 2), publications on cashew diseases were only available starting in 1974, with few articles published in the 1990s and an increasing trend detected only from 2010 onwards. However, the number of publications rarely exceeded more than 10 articles per year. Considering the great importance of cashew as a commercial crop among several tropical regions, along with the general perception by cashew farmers that diseases affect its productivity and the scientific advances in pathogen identification, the number of publications is expected to increase in the future.

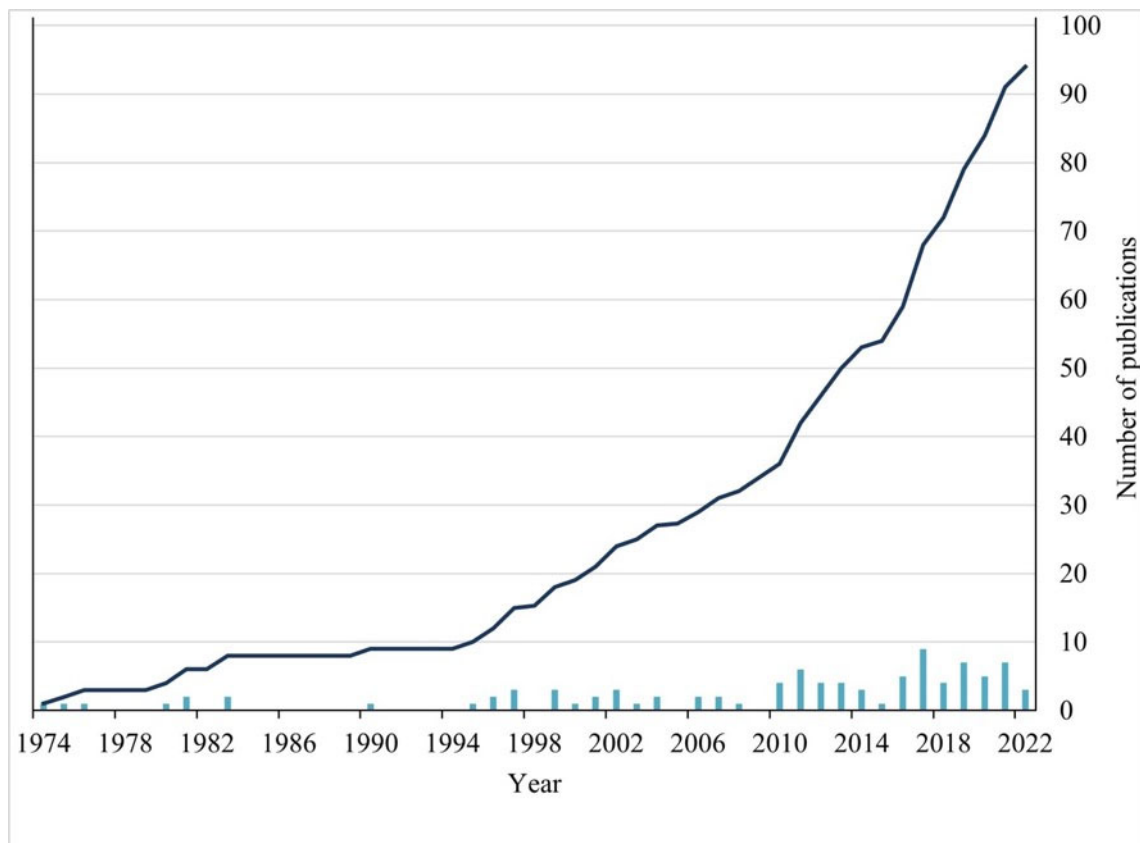


Figure 2. Cumulative number of publications (line) and number of publications per year (bars) on cashew diseases since 1974.

3.1.2. Pathogens Affecting Cashew

Among the pathogens found associated with cashew diseases, fungi were by far the most reported ones, being represented in a substantially higher number of studies (90) than bacteria (9).

Twenty-two different fungal genera were identified as associated with cashew diseases (Figure 3), whereas bacteria were represented by two genera only: *Xanthomonas* (6%) and *Candidatus* (2%). The most representative pathogenic fungal genera, recorded in 20 articles or more, were *Lasiodiplodia* (27%), *Erysiphe* (23%), and *Colletotrichum* (22%), followed by *Cryptosporiopsis* and *Fusarium* in eight articles (8.5%). In these, *Lasiodiplodia* was the most investigated fungal genus, accounting for 22% of the total fungal species recorded, with *L. theobromae* being the main *Lasiodiplodia* species referred in the literature as being pathogenic to cashew. The genus *Erysiphe* includes two species (*E. quercicola* and *E. necator*), the first of which was reported in most studies screened as the former species *Oidium anacardii*, which was recently reclassified as *Erysiphe quercicola* (Cardoso et al., 2017). *Colletotrichum gloeosporioides* was the most frequently recorded species from the genus *Colletotrichum*, but *C. chrysophilum* was also identified as pathogenic to cashew.

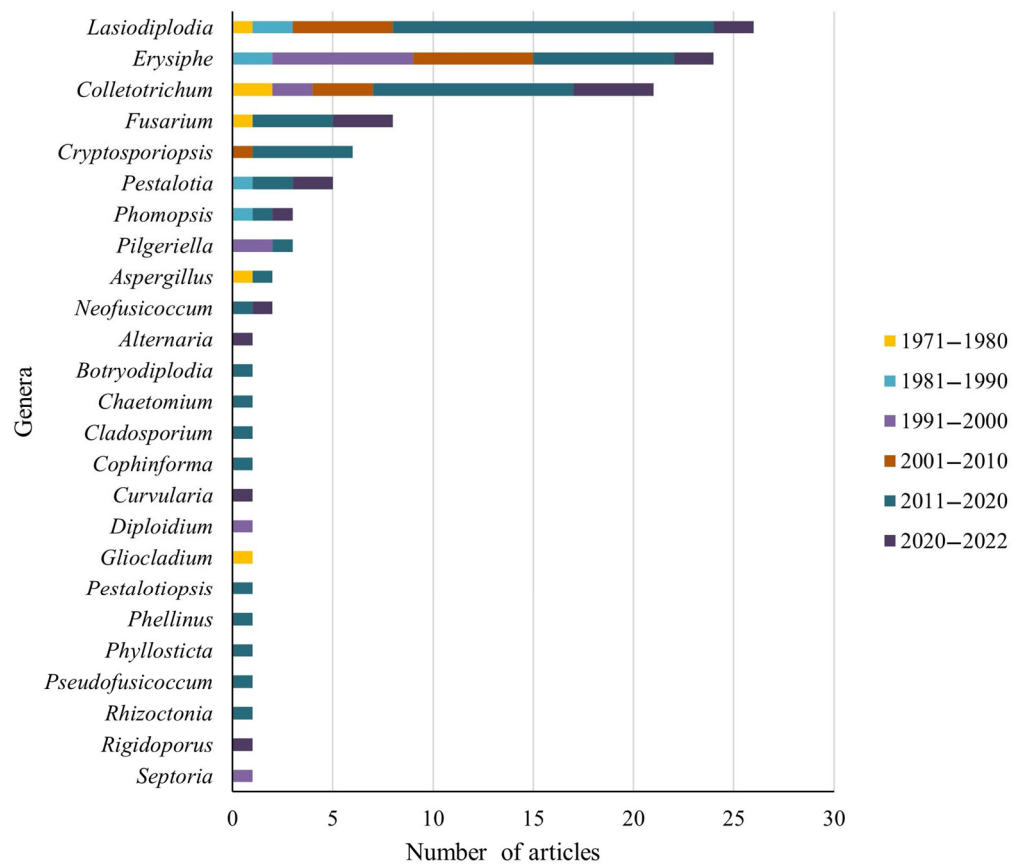


Figure 3. Number of articles reporting pathogenic fungal genera infecting cashew trees according to decade since 1971.

Regarding pathogen identification, nearly half of the studies (48%) only relied on the observation of plant symptoms in the field (Table S2) in response to pathogenic fungi, including dieback, flagging, wilting, chlorosis, and trunk cankers. Complementary methods such as morphological and cultural evaluation (e.g., assessment of shape, size, color of fungal colony, and mycelial growth rate) or molecular analysis (e.g., usage of molecular markers to achieve species identification using molecular biology techniques) of the pathogenic organisms isolated from symptoms were only found in 43% and 31% of the studies, respectively. These two methods have been used more recently, mainly since 2007, particularly in records addressing first reports of cashew diseases.

3.1.3. World Distribution of Cashew Diseases

Regarding the worldwide distribution of cashew diseases, Brazil and Tanzania were the top countries, accounting for about 60% of the studies that focused on the five major pathogenic fungal genera (Figure 4).

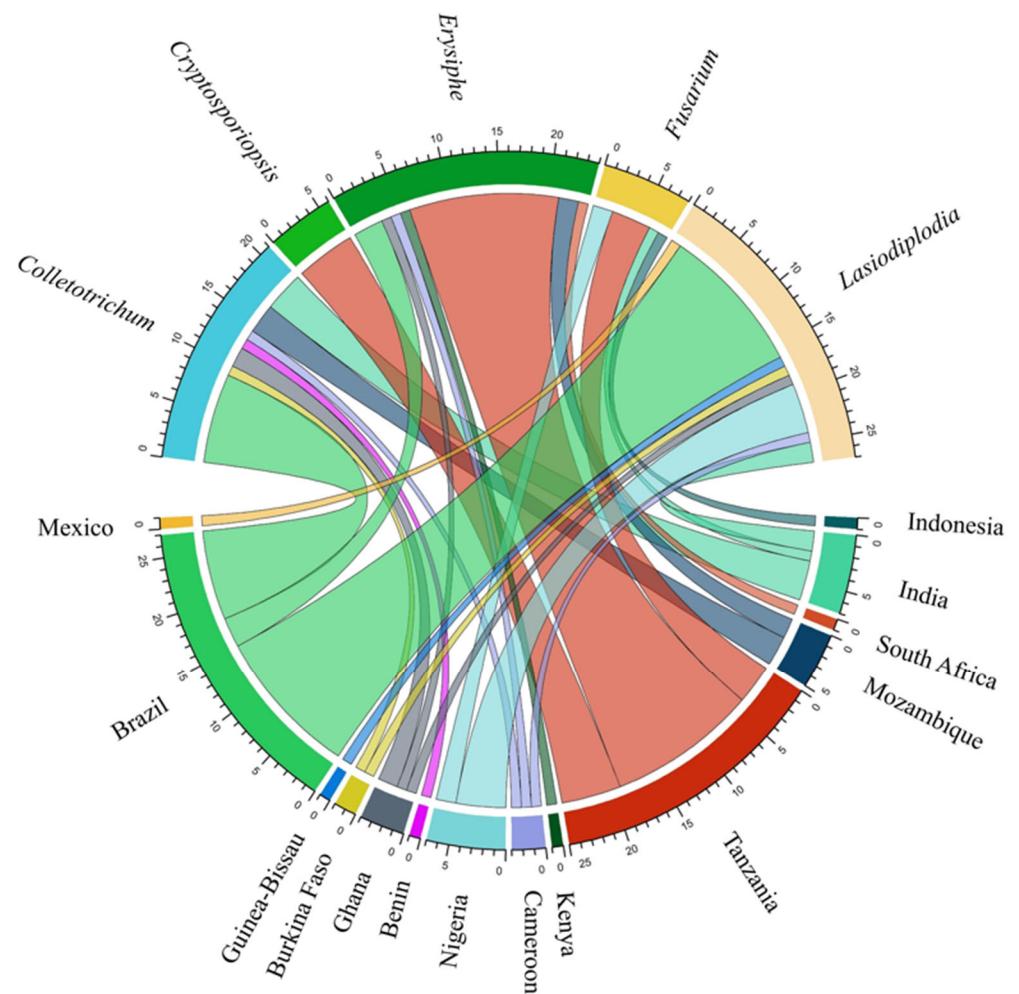


Figure 4. Chord diagram showing the relations between the genera and the countries where the studies were performed.

The analysis of the available information showed that the genera *Lasiodiplodia* and *Colletotrichum* were the cashew pathogens with the widest global distribution, having been reported in all cashew-producing regions of America, Africa, and Asia. *Cryptosporiopsis* seemed to be a fungal genus found exclusively in Africa because it only was reported in Tanzania, whereas *Lasiodiplodia* appeared to be missing from this region or simply no studies were found under the criteria used in the present analysis. Tanzania was also the most reported country for *Fusarium* and *Erysiphe*. However, these genera are present in other continents; i.e., *Fusarium* was reported in Indonesia (Asia) and *Erysiphe* in Brazil (America).

In Brazil, the country of origin of cashew, the most important pathogenic genera are *Lasiodiplodia* and *Colletotrichum* (Figure 5), while in eastern Africa, most of the studies that addressed pathogenic fungi infecting cashew referred to the genus *Oidium*, which currently belongs to *Erysiphe* and was recently reported in Brazil. In contrast, *Lasiodiplodia* was the genus reported in more countries. Benin, Mexico, South Africa, and Kenya were only reported in one study for only one genus.

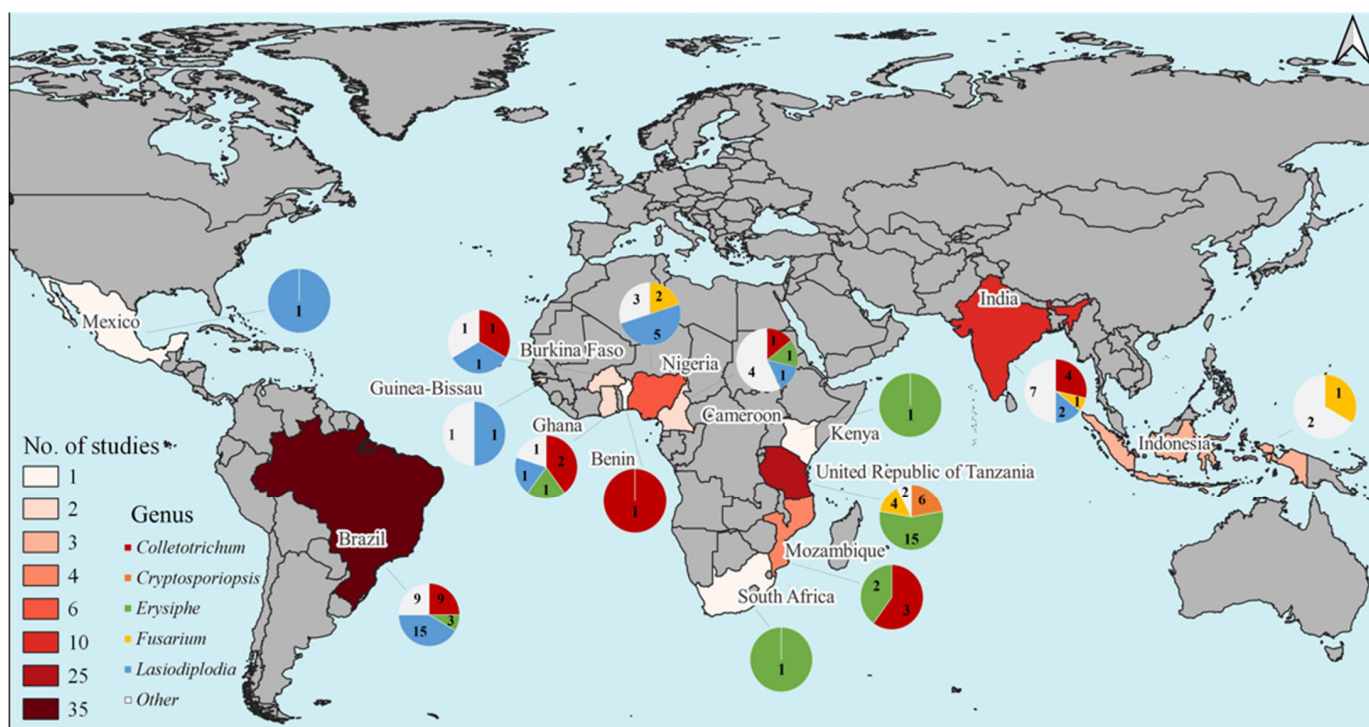


Figure 5. Worldwide distribution of studies on cashew diseases and major pathogenic fungal genera infecting cashew trees in each country. The light red (minimum) to dark red (maximum) color represents the number of studies per country. The pie charts show the proportion of studies focused on each genus next to the colored countries.

3.1.4. Plant Tissues and Incidence of Cashew Diseases

Information describing plant tissues affected by each pathogen were extracted from records addressing the most important fungal genera (with more than five records) (Figure S2). The chord diagram presents the relation between the genera and the plant tissues affected.

Most of such fungi infect the aerial parts of cashew tree; only *Fusarium* is reported to attack the roots. *Lasiodiplodia* and *Colletotrichum* infect all the aerial parts of cashew, including both the vegetative tissues (such as leaves, trunk, and stems) and the reproductive structures (such as inflorescences, apples (false fruits), and nuts (fruits)). The leaves and nuts are the most susceptible plant parts and are attacked by all the pathogenic fungal genera.

The selected studies were examined to identify those that reported field surveys measuring disease incidence/severity with the aim of identifying the most damaging pathogens affecting cashew culture. The only index calculated in the same way by several studies was the disease incidence, which was measured as the proportion (%) obtained by dividing the number of diseased plants by the total number of plants evaluated. This was recorded in a total of five studies that evaluated adult plants in cashew orchards. According to the literature, infection of cashew trees with *Lasiodiplodia theobromae* resulted in a mean disease incidence of 91% while incidence related to *Colletotrichum gloeosporioides* was 33%.

3.2. Major Cashew Diseases

Lasiodiplodia, *Erysiphe*, *Colletotrichum*, *Fusarium*, and *Cryptosporiopsis* were identified as the most representative pathogenic fungal genera, accounting for most of the records found (84 records; 89%). Although more than 10 fungal diseases are known to affect cashew, the present overview of the current knowledge published by the scientific community allowed us to assess which diseases are the major constraints to cashew worldwide and where they have been reported so far.

3.2.1. Gummosis and Dieback

Lasiodiplodia (Botryosphaeriaceae), which was the most frequently reported fungal genus in our study (25 records), is widespread across major cashew-producing regions, from its native country (Brazil) to West African countries and India. Most reports highlighted *L. theobromae* as the causal agent of cashew gummosis and dieback [21] except in Brazil and Guinea-Bissau, where different *Lasiodiplodia* species were ascribed to this disease [22–24]. *Lasiodiplodia* spp. are cosmopolitan pathogens that affect a wide range of crop hosts, including cashew [25], and cause gummosis and dieback. Cashew gummosis caused by *L. theobromae* was first reported in 1990 [26] and soon became one of the most important diseases in semi-arid northeastern Brazil [27]. It is characterized by symptoms such as branch dieback, stem cankers, gum exudation, necrotic lesions, seed and fruit decay, and foliage yellowing, and ultimately leads to plant death [28–32]. The identification of *L. theobromae* as the causal agent of both gummosis and dieback has relied mostly on plant symptoms and morphological characteristics of asexual reproductive structures (such as the size of conidia and pycnidia, as well as the growth rate and production of pigments in culture media) (Table S2). However, given that species boundaries are still unsettled in most fungal genera, pathogen identification solely based on morphological/cultural characteristics might be deceiving. In fact, molecular phylogenies using multilocus data provided evidence that *L. theobromae* should be considered a species complex [33–35]; since then, accurate identification methods using phylogenetic data together with morpho-cultural characteristics have identified more than 25 new species of *Lasiodiplodia*, which was previously classified as *L. theobromae*; e.g., [33,35–37]. The need to include multilocus sequence analysis (MLSA) was expressed by the most recent studies in Brazil and Guinea-Bissau, which identified *Lasiodiplodia* species other than *L. theobromae* that were associated with gummosis [22,23,38], as well as other Botryosphaeriaceae species such as *Neofusicoccum batangarum* and *Pseudofusicoccum stromaticum* [22]. Similarly, other species have been associated with cashew dieback in Brazil (e.g., *Cophinforma atrovirens* [39]) and in Guinea-Bissau (*N. batangarum* [24]). As such, it should be highlighted that previous data reporting *L. theobromae* might be incorrect; re-analysis using molecular tools will enable adequate identification at the species level. This is particularly important for cashew because, based on the current literature, the causal agent of cashew gummosis and dieback has been mostly identified as *L. theobromae* by relying on plant symptoms and/or morpho-cultural characteristics without a molecular identification at the species level. Considering the integration of molecular tools to support species identification, *L. theobromae* may not be regarded as a pantropical pathogen in cashew found from Brazil to the African continent and to India.

3.2.2. Powdery Mildew

Erysiphe appeared as the second most frequently reported fungal genus, with two species recently reported in cashew in Brazil: *E. quercicola* [40–42] and *E. necator* [42]. Cashew powdery mildew (CPM) has been considered a minor disease that affects young leaves, inflorescences, and nuts, reducing fruit onset and severely damaging apple and kernels [40]. Recently, following a CPM outbreak in Brazil that significantly reduced the yield and quality of nuts and apple, this disease became a major concern [40]. Based on morphological characteristics and molecular data, the causal agent of CPM was identified as *E. quercicola* [40]. Based on these new data, it was possible to determine that the fungus previously reported in Tanzania (Voucher MUMH781, Mie University, Mycological Herbarium, Japan) [43] under the anamorphic name of *Pseudoidium anacardii* (Noack) U. Braun & R.T.A. Cook, formerly known as *Oidium anacardii*, was in fact *Erysiphe quercicola* [44]. Studies on CPM until 2017 identified *Oidium anacardii* as the causal agent; hence, in our study, we considered this taxonomic arrangement to assess an up-to-date distribution of this cashew disease. The first record of the disease was in 1979 [45] from Tanzania (East Africa), where it was responsible for a decline of about 50–70% in cashew production [46]. Since the 1960s, it has been considered the major pathological problem in East African cashew-growing countries [47] because young shoots, inflorescences, young fruits, and leaves were severely

affected, reducing nut yields and apple quality. Our study identified the first reports of this disease in East African countries (Tanzania, Kenya, and Mozambique), South Africa, China, and more recently in Cameroon [48]; only in 2017 was it reported in Brazil, the native region of cashew (e.g., [40]). Recent reports from Brazil highlighted powdery mildew as the main disease that is constraining cashew production. A very interesting feature is that this disease only began to be considered a main concern in Brazil in the last decade, with most cashew varieties seeming to be susceptible to this pathogen [41]; while in East Africa, it has been the major disease for over 50 years.

3.2.3. Anthracnose

Colletotrichum, the third most frequently reported fungal genus, is recognized to cause anthracnose in several crops worldwide, with *C. gloeosporioides* being generally ascribed to cashew anthracnose [21,49–51]. The occurrence of cashew anthracnose was first reported in 1948 [52] in Brazil, where most studies were developed. The causal agent *C. gloeosporioides* is a common pathogen of other tropical fruit plants [53] that is highly variable in its cultural and morphological characteristics and its pathogenicity [54]. It can infect leaves, twigs, inflorescences, young apples, and fruits; symptoms include sunken subcircular or angular lesions. Symptoms in cashew start with water-soaked lesions, which turn orange to slightly reddish during sporulation [21]; with the infection onset, premature abscission of leaves or depressed lesions on the fruit may occur (Menezes, 2005). According to Veloso et al. [14], it is the main disease affecting cashew in Brazil. Most studies published to date on cashew anthracnose identified *C. gloeosporioides* as the causal agent either through morpho-cultural criteria and plant symptoms or by using molecular phylogenetic data with low-informative markers (Table S2). However, *C. gloeosporioides* is a species complex that is the widest within the genus [55], comprising at least 38 species including *C. gloeosporioides sensu stricto* [56]. In fact, *C. gloeosporioides* is considered as the most challenging species complex to resolve and is frequently regarded as a dumping taxon for diverse *Colletotrichum* fungi; in this sense, the species name is of little practical use [57]. Thus, the traditionally referred *C. gloeosporioides* may in reality correspond to different species or encompass a combination of species, many of which cannot be reliably distinguished using the internal transcribed spacer (ITS), the official barcoding gene for fungi [55,58]. For this reason, other genes have been proposed as secondary barcodes for species-level identification, such as glyceraldehyde-3-phosphate dehydrogenase (GAPDH) and glutamine synthetase (GS) [55], as well as several genes from the DNA lyase *Apn2*/mating-type locus [58]. Cashew anthracnose may fall into this challenging issue because pathogen molecular identifications performed up to now were mostly based on ITS [e.g., 51,53]. Data from our study highlighted *C. gloeosporioides* as the only causal agent of anthracnose in cashew described in India [59], West Africa [60,61], and Mozambique (East Africa [51]); while in Brazil, seven *Colletotrichum* species, namely *C. chrysophilum*, *C. fragariae*, *C. fructicola*, *C. gloeosporioides*, *C. queenslandicum*, *C. siamense*, and *C. tropicale* [14,62], were associated with cashew anthracnose. A major difference between studies in Brazil and the remaining countries/regions was the use of a multilocus phylogeny with resolving power to identify other *Colletotrichum* species beyond *C. gloeosporioides*. This is an important step in solving species-identification issues in cashew anthracnose, which should be promoted in cashew-producing regions, thus allowing the development of precise and effective control measures.

3.2.4. Other Fungal Diseases

Data collected from eight records on other fungal genera, namely *Cryptosporiopsis* and *Fusarium*, revealed that none of these pathogens was reported in Brazil, the native region of cashew. Reports on *Cryptosporiopsis*, which causes cashew blight disease infecting mainly the apple and nuts, were restricted to Tanzania ($n = 8$), with a high potential to decrease cashew productivity [47]. The *Fusarium* genus represented by a single species (*F. oxysporum*) was associated with root rot disease [63] and, more recently, with Fusarium wilt disease (FWD) in Tanzania [15], which mainly affects the leaf and root/stem and

ultimately leads to complete wilting of the cashew canopy and tree death [64]. Our study showed that *F. oxysporum* occurs in Tanzania (East Africa), Nigeria (West Africa), India, and Indonesia. Despite previous reports of root rot disease in Nigeria in 1974 [65] and afterward in Indonesia [63] and India [66], few studies highlighted *F. oxysporum* as a major pathogen in cashew. Nevertheless, due to the alarming scenario described in recent works from Tanzania [64], where cashew orchards have been devastated by FWD, cashew-producing countries should be vigilant regarding possible future infections by this pathogen. Indeed, due to the lack of proper disease-screening trials in cashew-producing countries, *Fusarium* should not be discarded as a minor pathogen and remains to be identified at the species level.

To a lesser extent, several other fungal pathogens were also identified from the genera *Pestalotia*, *Phomopsis*, *Pilgeriella*, and *Septoria*. Specifically, *Pestalotia* was found in Brazil, Burkina Faso, Venezuela, Nigeria, Tanzania, and India [47,67,68] to be infecting leaves and inflorescences and causing *Pestalotia* leaf spot [47,69]. *Phomopsis* spp. were detected in Brazil, Tanzania, and India [47,70] as the causal agents of leaf blight disease. This pathogen infects young leaves and in severe cases can lead to defoliation [70]. *Pilgeriella anacardii* was found in Brazil to exclusively infect cashew, affecting mainly the leaves and shoots and indirectly contributing to a loss in nut yield [71]. *Septoria anacardii*, which causes angular leaf spot cashew disease, is a pathogen specific to cashew that was only reported in Brazil [21]. Although less studied by the scientific community over the years, these cashew-disease-related fungi seem to be expanding while still presenting just local significance as cashew diseases.

3.2.5. Bacterial Diseases

Among the pathogenic bacteria reported in the analyzed studies, only two genera were identified: *Xanthomonas* and *Candidatus* (Table S2). The former was the most represented (8 out of 10 articles) and is known to cause cashew bacterial canker disease, resulting in premature fruit drop and reduced nut quality and commercial value [72]. This disease was first reported in cashew orchards in Brazil in 2004 and more recently in Burkina Faso (West Africa [72]), where it is considered of great concern and dissemination potential.

4. Conclusions

Although the description of a high number of pathogens associated with several diseases in cashew orchards can be found for many cashew-producing countries, studies that addressed the impact of such diseases in the field were scarce and focused only on the disease incidence and the severity analysis of gummosis (*L. theobromae*) and anthracnose (*C. gloeosporioides*). Based on the available data, gummosis is considered the most prevalent and damaging disease of cashew, with a pantropical distribution reaching more than 90% of the total planted areas, while anthracnose shows a quite low incidence and becomes of economic significance only when inflorescences and fruits are affected.

Other fungi genera documented to cause cashew diseases (e.g., *Septoria*, *Pilgeriella*, and *Pestalotia*) might correspond to emerging diseases that have not yet expanded to other geographic regions or that are still understudied. Africa seemed to be the region where most diseases were documented, with newly recorded ones such as *Fusarium* wilt disease currently restricted to East Africa and cashew blight caused by *Cryptosporiopsis* spp. not yet reported in the native cashew region (Brazil).

Understanding the extent of crop disease incidence, its damaging potential, and how it progresses in the field is crucial in assessing the risks to production and to delineate adequate control strategies. This seemed to be an important but missing research area in the current body of publications analyzed when considering, for instance, diseases such as cashew powdery mildew, which is emerging as a relevant threat in Brazil despite being a long-standing disease in East Africa.

In the present work, it was possible to disclose the discrepancy of causal agents ascribed to cashew diseases. Such was the case of gummosis, with many Botryosphaeriaceae

species indicated as causal agents. Proper species identification using both morpho-cultural and molecular approaches is still lacking. Our analysis revealed a scarce use of molecular tools for pathogen identification (31% of the studies) and even a low level of application of classical morpho-cultural criteria (43% of the studies), which could easily lead to misdiagnoses with serious negative consequences for the implementation of specific control actions. This may obviously result from insufficient resources in many cashew-producing countries to engage in more comprehensive studies. However, it was noticeable that despite the growing importance of cashew cultivation, research on cashew diseases is lagging behind that for other tropical cash crops. This problem must be tackled because it is crucial to improve biosecurity and disease control toward a sustainable production of cashew. It is important to establish a standardized identification workflow applied to cashew diseases that will allow a reliable identification of the disease-causing agent and to determine the occurrence and/or expansion of a given pathogen across cashew-producing regions.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/agronomy12102553/s1>, Figure S1. Number of records identified in each database; Figure S2. A chord diagram presenting the relation between the genera and the plant tissues affected. Table S1: Search strategy in Google Scholar (<https://scholar.google.com>) (a Web of Science (<https://www.webofscience.com/wos/alldb/basic-search>), and PubMed (<https://pubmed.ncbi.nlm.nih.gov>) databases/search engines for each query. All databases were assessed on 15 April 2022, using the search queries “cashew disease(s)”, “cashew bacteria(l) disease(s)”, “cashew fung(i_us_al) disease(s)”, and “first reports cashew”; while for the search query “Additional records identified through other sources”, databases were assessed on 10 June 2022; Table S2: List of articles retrieved from the search of the three databases, including: year of publication, reported disease, species, microorganism group, microorganism genus, plant tissue(s) affected, country, pathogen identification method, pathogenicity test, and indication if it was the first report of a disease; Table S3: List of articles retrieved from the search of the three databases (GS, PubMed, and WoS) using keywords for cashew diseases prior to removal of duplicates and data curation showing the authors, article title, publication Year, DOI, and database.

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Data Availability Statement: The data presented in this study are available in Supplementary Material Tables S2 and S3. Raw data retrieved from the three databases to analyze following the PRISMA guidelines presented in this study are openly available in Figshare at 10.6084/m9.figshare.20449806.v1 under reference number [20].

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References

1. Nair, K.P. Cashew Nut (*Anacardium occidentale* L.). In *Tree Crops: Harvesting Cash from the World's Important Cash Crops*; Springer International Publishing: Cham, Switzerland, 2021; pp. 27–77. ISBN 978-3-030-62140-7.
2. Monteiro, F.; Romeiras, M.M.; Figueiredo, A.; Sebastiana, M.; Baldé, A.; Catarino, L.; Batista, D. Tracking cashew economically important diseases in the West African region using metagenomics. *Front. Plant Sci.* **2015**, *6*, 482. [[CrossRef](#)] [[PubMed](#)]
3. Dubbert, C. Participation in contract farming and farm performance: Insights from cashew farmers in Ghana. *Agric. Econ.* **2019**, *50*, 749–763. [[CrossRef](#)]
4. Lundy, B.D. Cashews in conflict: The political ecology of cashew pomiculture in Guinea-Bissau. In *Political Ecology of Industrial Crops*; Ahmed, A., Gasparatos, A., Eds.; Routledge: London, UK, 2021; p. 26. ISBN 9780429351105.

5. Rico, R.; Bulló, M.; Salas-Salvadó, J. Nutritional composition of raw fresh cashew (*Anacardium occidentale* L.) kernels from different origin. *Food Sci. Nutr.* **2016**, *4*, 329–338. [[CrossRef](#)] [[PubMed](#)]
6. Havik, P.J.; Monteiro, F.; Catarino, S.; Correia, A.M.; Catarino, L.; Romeiras, M.M. Agro-economic transitions in Guinea-Bissau (West Africa): Historical trends and current insights. *Sustainability* **2018**, *10*, 3408. [[CrossRef](#)]
7. United Nations Conference on Trade and Development. *Special Issue on Cashew Nuts*; UNCTAD: Geneva, Switzerland, 2021; ISBN 9789210053839.
8. Monteiro, F.; Catarino, L.; Batista, D.; Indjai, B.; Duarte, M.C.; Romeiras, M.M. Cashew as a high agricultural commodity in West Africa: Insights towards sustainable production in Guinea-Bissau. *Sustainability* **2017**, *9*, 1666. [[CrossRef](#)]
9. Fitzpatrick, J. *Cashew Nut Processing Equipment Study-Summary African Cashew Initiative*, 1st ed.; Weidinger, R., Ed.; Deutsche Gesellschaft Fur: Bonn, Germany, 2011.
10. Hamed, L.A.; Anikwe, J.C.; Adediji, A.R. Cashew Nuts and Production Development in Nigeria. *Am. J. Sci. Res.* **2008**, *3*, 54–61.
11. Bezerra, M.A.; De Lacerda, C.F.; Gomes Filho, E.; De Abreu, C.E.B.; Prisco, J.T. Physiology of cashew plants grown under adverse conditions. *Braz. J. Plant Physiol.* **2007**, *19*, 449–461. [[CrossRef](#)]
12. Cardoso, J.E.; Viana, P.F.M. Capítulo 9: Impacto potencial das mudanças climáticas sobre as doenças do cajueiro no Brasil. In *Impactos das Mudanças Climáticas Sobre Doenças de Importantes Culturas No Brasil*; Ghini, R., Hamada, E., Bettiol, W., Eds.; Embrapa: Jaguariúna, Brazil, 2011; pp. 162–176. ISBN 9788585771515.
13. Serrano, L.A.L.; Neto, F.C.V.; Melo, D.S.; Cardoso, J.E. Influência do oídio nas castanhas de diferentes genótipos do cajueiro. [Influence of the powdery mildew in cashew nuts genotypes]. *Embrapa 40 Bol. Pesqui. Desenvol.* **2013**, *76*, 1–22.
14. Veloso, J.S.; Câmara, M.P.S.; Lima, W.G.; Michereff, S.J.; Doyle, V.P. Why species delimitation matters for fungal ecology: Colletotrichum diversity on wild and cultivated cashew in Brazil. *Fungal Biol.* **2018**, *122*, 677–691. [[CrossRef](#)]
15. Tibuhwa, D.D.; Shomari, S. Fusarium wilt disease: An emerging threat to cashew nut crop production in Tanzania. *Asian J. Plant Pathol.* **2016**, *10*, 36–48. [[CrossRef](#)]
16. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ* **2009**, *339*, b2535. [[CrossRef](#)] [[PubMed](#)]
17. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. [[CrossRef](#)] [[PubMed](#)]
18. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2022.
19. QGIS Development Team. *QGIS Geographic Information System*, version 3.26.3; QGIS Association: Switzerland, 2022.
20. Monteiro, F.; Romeiras, M.M.; Barnabé, J.; Catarino, S.; Batista, D.; Sebastiana, M. List of articles retrieved from the three databases search (GS, PubMed, WoS) using keywords for cashew diseases, prior to duplicates removal and data curation. *Figshare Dataset* **2022**. [[CrossRef](#)]
21. Freire, F.C.O.; Cardoso, J.E.; dos Santos, A.A.; Viana, F.M.P. Diseases of cashew nut plants (*Anacardium occidentale* L.) in Brazil. *Crop Prot.* **2002**, *21*, 489–494. [[CrossRef](#)]
22. Netto, M.S.B.; Lima, W.G.; Correia, K.C.; da Silva, C.F.B.; Thon, M.; Martins, R.B.; Miller, R.N.G.; Michereff, S.J.; Câmara, M.P.S. Analysis of phylogeny, distribution, and pathogenicity of Botryosphaeriaceae species associated with gummosis of *Anacardium* in Brazil, with a new species of *Lasiodiplodia*. *Fungal Biol.* **2017**, *121*, 437–451. [[CrossRef](#)]
23. Monteiro, F.; Diniz, I.; Pena, A.R.; Baldé, A.; Catarino, L.; Batista, D. First report of three *Lasiodiplodia* species (*L. theobromae*, *L. pseudotheobromae*, *L. caatinguensis*) causing cashew gummosis in Guinea-Bissau (West Africa). *Plant Dis.* **2020**, *104*, 2522. [[CrossRef](#)]
24. Diniz, I.; Batista, D.; Pena, A.R.; Rodrigues, A.S.B.; Reis, P.; Baldé, A.; Indjai, B.; Catarino, L.; Monteiro, F. First Report of Dieback Caused by *Neofusicoccum batangarum* in Cashew in Guinea-Bissau. *Plant Dis.* **2021**, *105*, 1215. [[CrossRef](#)]
25. Cardoso, J.E.; Santos, A.A.; Rossetti, A.G.; Vidal, J.C. Relationship between incidence and severity of cashew gummosis in semiarid north-eastern Brazil. *Plant Pathol.* **2004**, *53*, 363–367. [[CrossRef](#)]
26. Freire, F. A resinose do cajueiro. In *Caju Informativo*; Ano IV 1: 1–2, Embrapa Agroindústria Tropical: Fortaleza, Brazil, 1991.
27. Moreira, R.C.; Lima, J.S.; Silva, L.G.C.; Cardoso, J.E. Resistance to gummosis in wild cashew genotypes in northern Brazil. *Crop Prot.* **2013**, *52*, 10–13. [[CrossRef](#)]
28. Burgess, T.I.; Barber, P.A.; Mohali, S.; Pegg, G.; de Beer, W.; Wingfield, M.J. Three new *Lasiodiplodia* spp. from the tropics, recognized based on DNA sequence comparisons and morphology. *Mycologia* **2006**, *98*, 423–435. [[CrossRef](#)]
29. Zhao, J.P.; Lu, Q.; Liang, J.; Decock, C.; Zhang, X.Y. *Lasiodiplodia pseudotheobromae*, a new record of pathogenic fungus from some subtropical and tropical trees in southern China. *Cryptogam. Mycol.* **2010**, *31*, 431–439.
30. Lima, J.S.; Moreira, R.C.; Cardoso, J.E.; Martins, M.V.V.; Viana, F.M.P. Cultural, morphological and pathogenic characterization of *Lasiodiplodia theobromae* associated with tropical fruit plants. *Summa Phytopathol.* **2013**, *39*, 81–88. [[CrossRef](#)]
31. Marques, M.W.; Lima, N.B.; de Moraes, M.A.; Barbosa, M.A.G.; Souza, B.O.; Michereff, S.J.; Phillips, A.J.L.; Câmara, M.P.S. Species of *Lasiodiplodia* associated with mango in Brazil. *Fungal Divers.* **2013**, *61*, 181–193. [[CrossRef](#)]
32. Netto, M.S.B.; Assunção, I.P.; Lima, G.S.A.; Marques, M.W.; Lima, W.G.; Monteiro, J.H.A.; de Queiroz Balbino, V.; Michereff, S.J.; Phillips, A.J.L.; Câmara, M.P.S. Species of *Lasiodiplodia* associated with papaya stem-end rot in Brazil. *Fungal Divers.* **2014**, *67*, 127–141. [[CrossRef](#)]
33. Crous, P.W.; Slippers, B.; Wingfield, M.J.; Rheeder, J.; Marasas, W.F.O.; Phillips, A.J.L.; Alves, A.; Burgess, T.; Barber, P.; Groenewald, J.Z. Phylogenetic lineages in the Botryosphaeriaceae. *Stud. Mycol.* **2006**, *55*, 235–253. [[CrossRef](#)]

34. Phillips, A.J.L.; Alves, A.; Abdollahzadeh, J.; Slippers, B.; Wingfield, M.J.; Groenewald, J.Z.; Crous, P.W. The Botryosphaeriaceae: Genera and species known from culture. *Stud. Mycol.* **2013**, *76*, 51–167. [[CrossRef](#)]
35. Slippers, B.; Boissin, E.; Phillips, A.J.L.; Groenewald, J.Z.; Lombard, L.; Wingfield, M.J.; Postma, A.; Burgess, T.; Crous, P.W. Phylogenetic lineages in the Botryosphaeriales: A systematic and evolutionary framework. *Stud. Mycol.* **2013**, *76*, 31–49. [[CrossRef](#)]
36. Abdollahzadeh, J.; Javadi, A.; Mohammadi Goltapeh, E.; Zare, R.; Phillips, A.J.L. Phylogeny and morphology of four new species of *Lasiodiplodia* from Iran. *Persoonia* **2010**, *25*, 1–10. [[CrossRef](#)]
37. Linaldeddu, B.T.; Deidda, A.; Scanu, B.; Franceschini, A.; Serra, S.; Berraf-Tebbal, A.; Zouaoui Boutiti, M.; Ben Jamâa, M.L.; Phillips, A.J.L. Diversity of Botryosphaeriaceae species associated with grapevine and other woody hosts in Italy, Algeria and Tunisia, with descriptions of *Lasiodiplodia exigua* and *Lasiodiplodia mediterranea* sp. nov. *Fungal Divers.* **2015**, *71*, 201–214. [[CrossRef](#)]
38. Coutinho, I.B.L.; Freire, F.C.O.; Lima, C.S.; Lima, J.S.; Gonçalves, F.J.T.; Machado, A.R.; Silva, A.M.S.; Cardoso, J.E. Diversity of genus *Lasiodiplodia* associated with perennial tropical fruit plants in northeastern Brazil. *Plant Pathol.* **2017**, *66*, 90–104. [[CrossRef](#)]
39. Cardoso, J.E.; Fonseca, W.L.; Viana, F.M.P.; Ootani, M.A.; Araújo, F.S.A.; Brasil, S.O.S.; Mesquita, A.L.M.; Lima, C.S. First Report of *Cophinforma atrovirens* causing stem rot and dieback of cashew plants in Brazil. *Plant Dis.* **2019**, *103*, 1772. [[CrossRef](#)]
40. Cardoso, J.E.; Viana, F.M.P.; Ootani, M.A.; Martins, M.V.V.; Araújo, F.S.A. First report of *Erysiphe quercicola* causing powdery mildew on cashew in Brazil. *Plant Dis.* **2017**, *101*, 1327. [[CrossRef](#)]
41. Pinto, O.R.O.; Cardoso, J.E.; Maia, A.H.N.; Pinto, C.M.; Lima, J.S.; Viana, F.M.P.; Martins, M.V. Reaction of commercial clones of cashew to powdery mildew in northeastern Brazil. *Crop Prot.* **2018**, *112*, 282–287. [[CrossRef](#)]
42. Fonseca, W.L.; Cardoso, J.E.; Ootani, M.A.; Brasil, S.O.S.; Assunção, F.S.; Lima, C.S.; Viana, F.M.P.; Muniz, C.R.; Andrade, I.L.; Martins, M.V.V. Morphological, molecular phylogenetic and pathogenic analyses of *Erysiphe* spp. causing powdery mildew on cashew plants in Brazil. *Plant Pathol.* **2019**, *68*, 1157–1164. [[CrossRef](#)]
43. Limkaisang, S.; Takamatsu, S.; Cunnington, J.H.; Wui, L.K.; Salleh, B.; Sato, Y.; Divarangkoon, R.; Fangfuk, W.; To-anun, C. Molecular phylogenetic analyses reveal a close relationship between powdery mildew fungi on some tropical trees and *Erysiphe alphitoides*, an oak powdery mildew. *Mycoscience* **2006**, *47*, 327–335. [[CrossRef](#)]
44. Braun, U.; Cook, R.T.A. *Taxonomic Manual of the Erysiphales (Powdery Mildews)*; CBS biodiversity series; CBS-KNAW Fungal Biodiversity Centre: Utrecht, The Netherlands, 2012; ISBN 9789070351892.
45. Casulli, F. Il mal bianco dell’anacardio in Tanzania. *Riv. Agric. Subtrop. Trop.* **1979**, *73*, 241–248.
46. Martin, P.J.; Topper, C.P.; Bashiru, R.A.; Boma, F.; De Waal, D.; Harries, H.C.; Kasuga, L.J.; Katanila, N.; Kikoka, L.P.; Lamboll, R.; et al. Cashew nut production in Tanzania: Constraints and progress through integrated crop management. *Crop Prot.* **1997**, *16*, 5–14. [[CrossRef](#)]
47. Majune, D.J.; Masawe, P.A.; Mbega, E.R. Status and management of cashew diseases in Tanzania. *Int. J. Environ. Agric. Biotechnol.* **2018**, *3*, 1590–1597. [[CrossRef](#)]
48. Dooh, J.P.N.; Asta, C.B.D.; Djile, B.; Tchoupou, D.B.T.; Heu, A.; Mboussi, S.B.; Kuate, W.N.T.; Ambang, Z. Major fungi diseases of cashew trees (*Anacardium occidentale* L.) in Cameroon. *J. Agric. Sci.* **2020**, *13*, 124. [[CrossRef](#)]
49. Lopez, A.M.Q.; Lucas, J.A. *Colletotrichum* isolates related to anthracnose of cashew trees in Brazil: Morphological and molecular description using LSU rDNA sequences. *Braz. Arch. Biol. Technol.* **2010**, *53*, 741–752. [[CrossRef](#)]
50. Serra, I.; Menezes, M.; Coelho, R.; Ferraz, G.; Montarroyos, A.; Suely, L.; Martins, L. Molecular analysis in the differentiation of *Colletotrichum gloeosporioides* isolates from the cashew and mango trees. *Braz. Arch. Biol. Technol.* **2011**, *54*, 1099–1108. [[CrossRef](#)]
51. Uaciquete, A.; Korsten, L.; Van der Waals, J.E. Epidemiology of cashew anthracnose (*Colletotrichum gloeosporioides* Penz.) in Mozambique. *Crop Prot.* **2013**, *49*, 66–72. [[CrossRef](#)]
52. Rossetti, V. Anthracnose dos cajueiros. *São Paulo Biol.* **1948**, *14*, 269.
53. Figueirêdo, L.C.; Figueirêdo, G.S.; Quecine, M.C.; Cavalcanti, F.C.N.; Santos, A.C.; Costa, A.F.; Oliveira, N.T.; Azevedo, J.L. Genetic and pathogenic diversity of *Colletotrichum gloeosporioides*, the causal agent of cashew anthracnose. *Indian J. Fundam. Appl. Life Sci.* **2012**, *2*, 250–259.
54. Freire, F.; Cardoso, J. Doenças do cajueiro. In *Doenças de Fruteiras Tropicais de Interesse Agroindustrial*; Freire, F., Cardoso, J., Viana, F., Eds.; Embrapa, Informação Técnica: Brasília, Brazil, 2003; pp. 192–205.
55. Weir, B.S.; Johnston, P.R.; Damm, U. The *Colletotrichum gloeosporioides* species complex. *Stud. Mycol.* **2012**, *73*, 115–180. [[CrossRef](#)]
56. Jayawardena, R.S.; Hyde, K.D.; Damm, U.; Cai, L.; Liu, M.; Li, X.; Zhang, W.; Zhao, W.; Yan, J.Y. Notes on currently accepted species of *Colletotrichum*. *Mycosphere* **2016**, *7*, 1192–1260. [[CrossRef](#)]
57. Cannon, P.F.; Damm, U.; Johnston, P.R.; Weir, B.S. *Colletotrichum*—Current status and future directions. *Stud. Mycol.* **2012**, *73*, 181–213. [[CrossRef](#)] [[PubMed](#)]
58. Silva, D.N.; Talhinas, P.; Várzea, V.; Cai, L.; Paulo, O.S.; Batista, D. Application of the *Apn2/MAT* locus to improve the systematics of the *Colletotrichum gloeosporioides* complex: An example from coffee (*Coffea* spp.) hosts. *Mycologia* **2012**, *104*, 396–409. [[CrossRef](#)]
59. Abraham, M.; Padmakumari, G. A new leaf spot disease of cashew. *Indian Phytopathol.* **1980**, *33*, 626–627.
60. Muntala, A.; Kwadwo Gyasi, S.; Mawuenyegan Norshie, P.; Larbi-Koranteng, S.; Kwekucher Ackah, F.; Afreh Ntiamoah, D.; Atef Mohamed, M. Diseases and insect pests associated with cashew (*Anacardium occidentale* L.) orchards in Ghana. *Eur. J. Agric. Food Sci.* **2021**, *3*, 23–32. [[CrossRef](#)]
61. Houndahouan, D.E.T.; Sikirou, R.; Banito, A.; Basso, A.; Zinsou, V.; Amagnidé, A.G.Y.G.; Adomou, A.; Kouami, N. Assessment and diagnostic of cashew seedling diseases in nurseries in Benin. *Net J. Agric. Sci.* **2022**, *10*, 9–19. [[CrossRef](#)]

62. Veloso, J.S.; Lima, W.G.; Reis, A.; Doyle, V.P.; Michereff, S.J.; Câmara, M.P.S. Factors influencing biological traits and aggressiveness of *Colletotrichum* species associated with cashew anthracnose in Brazil. *Plant Pathol.* **2021**, *70*, 167–180. [[CrossRef](#)]
63. Supriadi, H.; Taufik, E.; Harni, R. Evaluation of resistancies of ten accessions of cashew to Fusarium Root Rot Disease. *J. Ind. Beverage Crop* **2011**, *2*, 125–130.
64. Amiri, N.; Tibuhwa, D.D. Antimicrobial activities of endophytic fungal crude extracts isolated from cashew tree (*Anacardium occidentale*). *Tanzan. J. Sci.* **2021**, *47*, 1102–1113. [[CrossRef](#)]
65. Esuruoso, O.F. Fungi associated with kernel rot disease of cashew (*Anacardium occidentale* L.) IN Nigeria. *Int. Biodeterior. Bull.* **1974**, *10*, 57–59.
66. Khatoon, A.; Mohapatra, A.; Satapathy, K.B. Major diseases of cashew (*Anacardium occidentale* L.) Caused by fungi and their control in Odisha, India. *Int. J. Biosci.* **2017**, *11*, 68–74. [[CrossRef](#)]
67. da Ponte, J.J. Mapeamento e importância das doenças do cajueiro no nordeste do Brasil. *Nematol. Bras.* **1986**, *10*, 59–68.
68. Wonni, I.; Sereme, D.; Ouédraogo, I.; Kassankagno, A.I.; Dao, I.; Ouedraogo, L.o.; Nacro, S. Diseases of cashew nut plants (*Anacardium occidentale* L.) in Burkina Faso. *Adv. Plants Agric. Res.* **2017**, *6*, 78–83. [[CrossRef](#)]
69. Adeniyi, D.O.; Orisajo, S.B.; Fademi, O.A.; Adenuga, O.O.; Dongo, L.N. Physiological studies of fungi complexes associated with cashew diseases. *ARPN J. Agric. Biol. Sci.* **2011**, *6*, 34–38.
70. Patil, P.D.; Baikar, A.A.; Raut, R.A. Impact of climate change on cashew leaf blight disease. *Plant Arch.* **2016**, *16*, 119–121.
71. Viana, F.M.P.; Lima, J.S.; Lima, F.A.; Cardoso, J.E. Control of cashew black mould by acibenzolar-S-methyl. *Trop. Plant Pathol.* **2012**, *37*, 354–357. [[CrossRef](#)]
72. Zombre, C.; Sankara, P.; Ouédraogo, S.L.; Wonni, I.; Boyer, K.; Boyer, C.; Terville, M.; Javegny, S.; Allibert, A.; Vernière, C.; et al. Natural infection of cashew (*Anacardium occidentale*) by *Xanthomonas citri* pv. *mangiferaeindicae* in Burkina Faso. *Plant Dis.* **2015**, *100*, 718–723. [[CrossRef](#)]