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The main diseases in the culture of pineapple: a review

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Abstract. Pineapple is a crop of great importance, having vitamins, minerals and capable of preventing diseases. Therefore, several researchers are interested in studying this crop, in addition to its use for other purposes, such as the production of juice pulp, jellies, sweets and other products, with its in natura form being the most sought after among countries. However, the attack of pathogens reduces pineapple production to worrying levels, and when not controlled, it even eradicates the entire plantation. Based on this, this review aimed to show the recent discoveries about the pineapple culture, emphasizing, mainly, the main diseases of this production chain. After gathering the main information on the most frequent diseases in pineapple production fields, we observed that fusariosis is considered the main disease of pineapple, followed by black spot, eye rot and root rot, being in short knowledge of these by producers is important in order to avoid irreversible damage. It is understood that more research is needed, since in the literature there are few

field studies on this crop, especially with regard to seeking alternative means of controlling these diseases, so that the dissemination of this knowledge provides better information on agronomic interests.
Keywords: *Ananas comosus*, Losses, Fusariosis.

Contextualization and analysis

In Brazil, the fruit market is a sector of great importance in national agribusiness, where it expresses its productive and commercial potential, considered a very complex and diversified branch. Pineapple (*Ananas comosus* L.), is a crop that stands out in the country, especially in the North and Northeast regions (Ibge, 2018), considered a perennial herbaceous plant of the *Bromeliaceae* family and genus Ananas (Noronha et al., 2016). Among the Brazilian producing states, Paraíba expresses itself positively in the production of this crop, accounting for 51.49% of the production in the Northeast region (Conab, 2020).

According to research carried out by the Food and Agriculture Organization of the United Nations (FAO), among the producing countries that lead the world ranking in pineapple production, the Philippines is the main producer (27.02 million tons), followed by Costa Rica (26.24 million tons) and Brazil (25.26 million tons) (FAO, 2020). As a result, this crop has economic and social impacts that can be facilitated with good planning and marketing technologies, however, there is a strong risk in the face of the challenges that are faced during the cultivation process until the material is harvested (Conab, 2020).

In pineapple cultivation, diseases are the most harmful challenges for the good development of the crop, which are present during the production and post-harvest phases, being essential the use of efficient management so that one can describe and identify these agents that cause diseases (Souza et al., 2018). In this culture, fusariosis (*Fusarium* spp.) is the most representative disease, capable of causing irreversible losses, being widely distributed in all producing states in Brazil (Nogueira et al., 2014).

Based on the above, it is understood that fruit growing presents challenges for its full development, with important improvements regarding the production process, since it is an activity that is strongly attacked by biotic factors such as pathogenic biological agents. With this, it is necessary to understand and disseminate knowledge and information about the main diseases in the pineapple crop, in order to contribute to the mitigation of risks related to this condition.

In this review, we will gather the main information about the most frequent diseases in pineapple production fields, in order to facilitate their understanding and contribute to advances in this area of study. Therefore, the present work had as objective to show the recent discoveries about the pineapple culture, emphasizing, mainly, the main diseases of this productive chain.

Methods

type of search

The study refers to a research with a qualitative approach, carried out through a descriptive analysis, with the indirect documentation technique, being characterized as a narrative literature review.

As for the technical procedures employed, it is of the indirect documentation type, making use of documentary research, specifically for data collection and bibliographical research. Prodanov and Freitas (2013), describes that bibliographical research also has a documental aspect since technical and scientific documents are used in the research.

Thus, it is a literature review of the narrative type, in which, according to Cordeiro et al. (2007), refers to a research method where other studies and research on the same subject are sought, without the need to use explicit and systematic criteria for the search and critical analysis, without the need to exhaust a particular source of data, therefore performing a broad search where the data is selected.

Technical procedures

To carry out the research, works published through data from websites and databases in consultations through digital libraries were used: the Scientific Electronic Library Online (SCIELO), Conab, FAO, Embrapa, Periódico CAPES, Web of scienses and SCOPUS , in the period of the last 5 years or more that are relevant to the study concerned, without language restriction or exclusion criteria, with information present in a database available on the internet and in books, thus being able to be found in the original source in the research. To select the articles, the following descriptors were used: “Ananas comosus”, “Pineapple”, “Diseases in pineapple”, “Cultivation of pineapple”, “Fusariosisin pineapple”, among others.

Because it is a narrative literature review, in which the choice of studies to compose the theoretical foundation of the research does not require the exhaustion of a data source, there was no defined flowchart referring to each stage of research selection, considering the amplitude used.

Thus, with the selection of data, it became possible to describe the main diseases affected in the pineapple crop and future perspectives in the production of this commodity. information collected was through consultation in publications of reference authors in the study area with subsequent critical reading on the subject.

The importance of pineapple in Brazil and in the world

Pineapple (*Ananas comosus* L.), is a fruit plant belonging to the *Bromeliaceae* family, of high relevance for Brazil and the world, with data that

report its origin in the Americas and with good adaptability to tropical and subtropical climates (Conab, 2020).In Brazil, pineapple is present in all regions, with a share of 34.59% (North), 32.29% (Northeast), 26.66% (Southeast), 1.39% (South) and 5.07 % (Midwest) (Conab, 2020).

According to data from Conab (2020), Pará was the leading Brazilian state in pineapple production, with a fruit production equivalent to 357,021 thousand, followed by the state of Paraíba with a production of 372,285 thousand fruits. These data collected are not a surprise, considering that pineapple is a fruit with high energy value, standing out among many other fruits for having sugars and nutritional value in its composition, in addition to mineral salts such as Ca, P, Mg, K, S, Cu and I, and vitamins such as C, A, B1, B2 and Niacin (Bazzi, 2020).

In addition, pineapple is considered a fruit with nutraceutical purposes, capable of helping to regulate muscle activity of the heart and aiding in good immune functioning, helping to fight infections, rheumatic cases and among other diseases that affect human health (Schrvensquy, 2015).

In Brazil, pineapple cultivation is mainly intended for domestic consumption, however, in mid-2018 there was a relevant increase in terms of fruit exports, especially in natura, as well as processed in the form of juices, with exports to countries such as Argentina, Uruguay and Portugal (Conab, 2020).

Worldwide, in 2017 exports accounted for 13.4% of pineapple production, with emphasis on countries such as Costa Rica, the Philippines and the Netherlands, with a shipment volume of 2.2; 0.5 and 0.3 million tons, respectively (FAO, 2020). The foreign exchange income generated by all exporting countries as a whole was equivalent to US$ 2.1 billion.

Even though Brazil stands out as the third largest pineapple producer in the world, its export to other countries is not expressive, since the domestic market absorbs almost everything that is produced, a fact that proves that in 2019 only 2.3 thousand tons of pineapple fruits were exported to other countries, which corresponds to less than 1% of the total produced in the country, with revenue obtained from this exported volume of approximately US$ 1.2 million (MAPA, 2020).

In 2021, according to data from Comexstat/ME 2022, the export of pineapple from fresh to preserved fruits was verified, as can be seen in Table 1.

Table 1. Pineapple exports in the year 2021[1].

Year - 2021	Volume (Kg)	Value (US$)	Average price (US$/t)
Fresh or dried pineapples	5,538,901	3,113,691	578,23
Pineapple prepared or preserved in sweetened water, ETC	653,749	975,871	1,492,73
Pineapple juice with BRIX value <= 20	481,715	292,215	606,61
Other pineapple juices	12,083,412	21,811,426	1,805,07
Pineapples prepared or otherwise preserved	52,889	86,169	1,629,24

[1]**Fonte:** Adaptado de Comexstat/ME (2022).

Thus, the strong importance of this culture is understood, especially for its various purposes of use, such as in the manufacture of sweets, jellies, wines, liqueurs, vinegars, syrups and ice creams, giving prominence in several countries, which leads to an increase in considerable production when compared to other fruit trees (Dantas, 2023).

In this sense, it is noticeable that pineapple is a prominent crop in Brazil and in the world. However, several etiological agents have been reported in the literature as capable of attacking pineapple production fields, bringing negative consequences for production, productivity and fruit quality.

The most common diseases in pineapple

Fusariosis (Fusarium guttiforme)

In Brazil, fusariosis is a disease caused by the fungus Fusarium guttiforme Nirenberg and O'Donnell (sin. *Fusarium subglutinans* f. sp *ananas*), considered the main phytosanitary limitation of pineapple, with a higher incidence in susceptible cultivars, such as 'Pérola' and 'Smooth Cayenne', which, consequently, are the most planted in the different producing regions of the country (Embrapa, 2021).

The genus *Fusarium* belongs to the Ascomycetes family, which comprises phytopathogens and saprophytes that cause harmful symptoms to plants, directly affecting the fruit (commercial part) and, if not handled efficiently, leads to the death of the entire plant (Retana et al., 2018).In addition, pineapple fusariosis has the ability to affect productivity, leading to significant losses of between 50 and 100% of the fruits, making it important to adopt efficient cultural practices to control the disease (Garcia et al., 2017; Paulino et al., 2019).

In the pineapple stem, the fungus acts by promoting odors that resemble fermented sugar cane, unlike the fruit, which is observable a kind of gum, influencing the yellowish tones of the fruits early without ripening, causing deformation in the its structure (Oliveira Silva, 2019).

This fungus tends to be easily disseminated through infected seedlings, in addition to the action of rain, wind and insects that settle on the leaves of

the pineapple tree until it achieves viable conditions for its good development, with greater adaptation to temperatures between 15 and 25°C, high relative humidity and high rainfall, acting mainly in the pre-harvest, since the symptoms manifest themselves in the crop before the fruit harvest, but which has a high capacity for post-harvest action with damages that affect commercialization,thus, it is necessary to use alternative measures to control this disease.

For this disease, control methods can be chemical (fungicides), cultural (use of healthy seedlings and floral induction in unfavorable periods for the disease) and genetic (resistant cultivars), the latter being considered the best method of controlling fusariosis, since in addition to being ecologically correct for not harming the environment, it offers the producer the guarantee of not using fungicides on a large scale, which in turn reduces expenses with this type of management (Viana et al., 2020).

In addition, there are residue limits present in the edible portion of the fruit when they are imported, in which countries have regulations on the amountof residues present in the consumable material (Vilaplana et al., 2018).

Thus, it is clear that fusariosis is an important pineapple disease in terms of the damage that is affected and harmful to this crop, requiring producers to adopt viable techniques, such as the choice of cultivar and cultural practices throughout the production cycle (Andrade et al., 2021).

Searching in depth in the literature about this disease, the rich information is noticeable, as presented above, however, there are few field studies that seek alternative means of controlling fusariosis. In addition, studies in the literature are largely focused on chemical control and the use of resistant cultivars to eradicate or control the fungus, emphasizing the idea of being the only viable technique for pineapple production.

However, other diseases are commonly found in pineapples, such as black spot, and their study is important to present the most relevant information about the disease.

Black spot (*Penicillium funiculosum* Thom)

The black spot present in pineapple fruits, caused mainly by fungi of the genus *Penicillium funiculosum* Thom, is present in all pineapple producing regions worldwide, including Brazil, capable of causing irreversible damage to production fields, especially depending on the inoculum potential, cultivars used and fruit production period (Matos & Sanches, 2007). The same authors also point out that this disease has a peculiar characteristic, since it is associated with the pineapple fruit mite (*Steneotarsonemus ananas* Tyron), which acts as a transmitter of the pathogen.

In Brazil, the 'Smooth Cayenne' and 'Pérola' cultivars, as they are the most cultivated in the producing regions, suffer greater attacks of the disease, in which they generally do not show external symptoms, these remaining in the inner part of the fruit, being possible to observe them after carrying out cutting material for in natura consumption or industrial processing, which may cause worrying losses (Embrapa, 2021; Matos & Sanches, 2007).

In the literature, there are few recent studies focused on this disease, which is worrying, since it is expressed in fruits as soft rot or dry rot, and due to the absence of symptoms in infected fruits, it becomes a difficult task to discard of the material in batches that are intended for export in natura.

Verzignassi et al. (2009), studying this disease, observed that its occurrence is more propitious in periods of greater rainfall followed by the dry season, before the flowers open, which favors the greater number of the disease in the fruit, making them unsuitable for commercialization, as it causes rotting of the pulp.

The literature shows that the control of this disease is a difficult practice, taking intoaccountthe chemical control of the mites during the stage of greater susceptibility of the inflorescence. However, the main producing regions choose to use chemical pesticides to reduce the mite population present in the inflorescences, requiring studies that address the implementation of integrated control measures to increase the efficiency of this technique.

In pineapple, another disease that is highly present i eye rot, capable of causing severe losses in production. Thus, it is essential to observe its consequences and its causative agent.

Eye rot (*Phytophthora nicotianae* var. *parasitica*)

This disease is caused by a fungus (*P. nicotianae* var. *parasitica*), present in the soil and capable of causing losses in agricultural crops, such as pineapple, especially in areas subject to waterlogging (Noronha et al., 2015).According to the same authors, its incidence happens especially in the first months after cultivation, as well as after the floral induction treatment, causing the rotting of the plant's eye, leading to its death if not controlled.

After being infected by the disease, the plant tends to show changes in the color of the younger leaves, changing their tone from green to dull yellow and gray, with the appearance of lesions on the basal part of the leaves without the presence of chlorophyll, which tend to expand from forms slightly over the other parts of the plant, reaching the stem, and in more advanced stages, a rot with a strong odor is noted (Noronha et al., 2015).

The few studies in the literature on the disease address that *P. nicotianae* var. *parasitica* has the ability to infect the pineapple crop at any stage of development, in which the soil contaminated by the pathogen, taken to the sites of infection during cultural management such as weeding, or even irrigation, are the main sources of inoculum(Matos & Sanches, 2007).

Almeida et al. (2014), when studying growth characteristics in pineapple as a function of the irrigation and fertilization system, found the

occurrence of P. nicotianae var. parasitica, in which they found the efficiency of its control after the use of chemical products recommended for the disease.Thus, it is clear that it is a disease of easy access to pineapple production fields, requiring adequate management after its identification.

For these reasons, research indicates that the control of *P. nicotianae* var. *parasitica* should be done routinely during culture development, with special attention to periodsimmediately after planting and after floral induction. In this way, it becomes possible to control this disease, which is highly harmful to the pineapple crop.

So far, it has been possible to understand that there are diseases that cause severe damage to the pineapple crop, such as those mentioned above. However, it is important to highlight root rot, a disease that has been gaining ground in national plantations, so its understanding must be takeninto account.

Root rot (*Phytophthora cinnamomi*)

Root rot is a disease that has already been taken into consideration by several researchers, since its incidence is present especially in producing regions where the volume of rain is concentrated in the hot months, soils with poor drainage and tendency to alkalinization (Oliveira Silva et al., 2019).

Species of the genus *Phytophthora*, belonging to the class Oomycetes, are a group of fungus-like organisms that are primarily plant pathogens and are widely spread throughout the world (Lourenço et al., 2020). Among the hosts, the pineapple crop becomes one of the most affected.

Pineapple is a crop that has a root system that is extremely sensitive to the occurrence of fungi, mainly *Phytophthora cinnamomi*, which causes root rot (Oliveira Silva et al., 2019). Initially, there is a loss of color in the leaves, changing from green to yellow, and they may curve towards the ground, a fact that occurs due to the loss of turgidity, and after being removed from the ground, the root of the plant is completely rotten (Amorin, 2016).

When the symptoms are present in the plants, they can be easily removed from the soil, as their roots are already completely rotten.It becomes clear that this genus stands out for the important diseases it is responsible for, which represent some of the greatest economic and cultural losses.

Despite the importance of pathogen control for *P. cinnamomi*, given its harmful impact on the economy and biodiversity, existing studies are limited and most of the time aimed at making the plant more tolerant to infection (Sena et al., 2018).

The researchers point out that the best control of the disease basically occurs before planting, when choosing the area for cultivation, and it is fundamental at this stage to carry out a soil analysis, being necessary that it is within the pH range between 5 and 5.5, and should be light, well drained and airy.

We observed that several diseases are present in the pineapple culture, however, some, such as those mentioned here, stand out with a much greater level of damage when compared to the other diseases that can affect the pineapple production fields.It is evident that studies on such diseases are limited, especially in the pineapple crop, however, it is the duty of the scientific community to seek to carry out more studies on such diseases, especially when considering that pineapple is among the most important fruit trees at a global level, but that its productivity may be affected by the incidence of diseases mentioned in this review.

Final considerations

Pineapple is among one of the main fruit trees in Brazil, with strong economic importance and present in several producing countries, given its high acceptance in the market.

The diseases present in pineapple plantations are considered to be the main obstacles to this crop, highlighting fusariosis, considered the main disease of pineapple, followed by black spot, eye rot and root rot, with the utmost importance being the knowledge of these by the producers, in order to avoid irreversible damage.

It is understood that further research is needed in order to provide better information on agronomic interests.

Author contributions

For the development of this article, the authors actively participated in the review and discussion of the data.

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