



## **Crop Rotation: A Sustainable Practice for the Management of Diseases**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

The management and environmental impacts influence agricultural production, diseases, in turn, can interfere and cause damage to the crop at different times and parts of the plant, due to economic loss, it is necessary to use disease control methods. To maintain sustainable agricultural production, disease management is necessary. Many methods are adopted in agriculture during its development, and led to the implementation of various production systems, including the no-till system, which helped boost production. However, no-tillage was found to have several soil conservation problems, making it necessary to adopt another practice in this system, which is crop rotation, which emerged as a sustainable means of soil conservation, bringing several benefits. Crop rotation is the planned and orderly alternation of different crops in a given period of time and in the same area, making the development and survival of pests and pathogens that affect crops difficult. Along with sustainable disease management using biological control and methods plant-based, allowed for better disease management in agriculture and provided a more sustainable production environment. Crop rotation is important in disease control because it can be a preventive practice to provide diversity to the system through breakage cycles. The control of these diseases can be done through the biological control of pests and plant extracts.

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## 1. INTRODUCTION

The agricultural production system is affected by several factors, and these factors cause the productivity of a certain crop to be higher or lower in the crop cycle. Understanding these factors that affect production is important for the cultivation of a crop, in order to make a better decision.

For agricultural productivity to reach higher levels, it is necessary to pay attention to environmental factors and crop management, using techniques and practices, which will contribute to plant production in the crop cycle, contributing during its cultivation and in different agencies of plants, favoring the increase in final productivity [1,2].

In crop management, it is necessary to intensify agricultural production in a sustainable way and seek solutions to fight diseases, pests and weeds that affect crops, cause damage and reduce crop production [3, 4].

On the production side, Brazil has been increasing its crop production. In 2020 it produced over 980 million tons of agricultural products, in an area of 80.2 million hectares, and in 2019 it produced over 968.7 million tons of agricultural products, in a harvested area of 77.9 million hectares, noting the increase in its production that was derived from the different production factors [5].

This need to intensify the increase in production is due to the constant growth of the world population, which according to FAO [6] in 2050 the population will be 9.8 billion, 29% more than the current number, and meet the food demand of the whole this population, it is estimated that food production should increase by 70%.

Thus, the factors for crop production must be better adjusted to increase production, and thus meet the demand of the population. But for this it is essential to adopt management practices that increase crop production, and an important management practice is that involves the disease control.

Plant diseases can cause significant losses in the yield of various crops, even causing the total loss of the crop, if the disease is not properly managed. Thus, knowledge of the disease, and

especially the means of control, becomes necessary, so that finally, it obtains an adequate management of diseases (7,8).

To maintain control of diseases caused by fungi, bacteria, viruses, nematodes and protozoa in agriculture, several disease control methods have emerged, such as physical control, biological control, chemical control, and cultural control [9,8].

However, an indiscriminate use of chemicals in agriculture has caused many problems, such as environmental impacts, with regard to contamination of the environment. In humans, food contamination causes poisoning. In plants, diseases are difficult to control due to the development of resistance to a particular chemical by the pathogens, thereby affecting chemical management of plants diseases (10, 11, 12].

However, current agriculture follows the premises of sustainable development, with this, it seeks alternative means of control, and to solve these problems, and also to ensure quality food, the most commonly used control methods together are the methods chemical, genetic and cultural control, which together reduce the amount of chemical products applied in the crop [9, 13].

Within cultural control, one of the most commonly used practices in production systems, and even in the no-till system, is the crop rotation. This comes as an alternative and favorable means of implementing crops in the agricultural sector.

In crop rotation, there is no fallow (barren) of the land, and whenever possible the soil will be continuously covered with crop, enabling production in all available soil, and practically throughout the year. In addition, there is the use of various crops in its a production system that helps to leverage agricultural production by affecting various factors of production, including disease [14] (Coelho et al., 2019).

## 2. LITERATURE REVIEW

### 2.1 Diseases in Plants

According to Artuzo et al. [15] crop production is variable, and depends on many factors, environmental and local aspects and the basic

techniques adopted for crop production, being influenced by environmental and management conditions.

Management involves a dynamic of technical aspects, such as biotechnology, direct planting, pest and disease control, the effectiveness of the use of agricultural inputs and precision technologies that ensure better use in the culture [15, 16].

Regarding the management of diseases, a variety of diseases affect crops, some with very specific characteristics, others more general, but causing damage to agricultural production. Thus, it becomes necessary to manage diseases to ensure that the crop expresses its potential of production.

In order to guarantee the maintenance of the productive potential of the cultivated plants, disease management must be carried out, even with the difficulties and implications encountered. It is essential to properly control the disease, and as a strategy a good diagnosis of the disease to be controlled must be carried out. [17].

A disease only occurs when there are favorable conditions for the development of the pathogen capable of infecting the crop, as well as environmental conditions that favor the spread of the pathogen. Plant diseases can be of fungal, bacterial, viral and/or phytonematosis origin. The knowledge of the disease and the basic causes of its occurrence, such as: the susceptibility of the host to the disease, the presence of pathogen inoculum and the favorable system for the infection, can be important factors to constitute a well-defined control strategy that allows for more effective management. effective disease. (7,18, 17).

According to Silva et al. [19] for the control of plant diseases in agriculture, the MID (Integrated Disease Management) is one of the recommended techniques for the control of phytopathogens and is based on the use of several combined methods that can prevent the spread of phytopathogenic agents, help reduce the possibility of selecting resistant crop varieties and to reduce the damage caused by the environment.

The rate of spread of a disease in plants depends on the current conditions of the crop and the susceptibility to infection, that is, it depends on its current status, and how the plant

will interact with the pathogen, demonstrating that plant management is essential for enable the plant to be in better conditions in the pathogen-plant relationship [20, 18].

Many diseases affect crops and are classified according to the phytopathogenic agent and the plant organ that are attacked. They are classified into groups as: reserve organ rot; damping; root and collar rot; systemic; stains, rust, powdery mildew; and viruses, galls, coal. As diseases act in different places of the plant, according to management practices, they must be carried out according to their presence in the production system, and methods that enable better disease control must be adopted [21, 18, 9].

Among the disease control methods, one of the control methods is the use of crop rotation, which is a sustainable method, and which provides several other benefits of producing a crop.

## 2.2 Rotation of Crops

To meet the population's food demand, as changes in the agricultural sector with technological advances and cultivation strategies that have led to increased food production. One of these advances was the use of the no-tillage system that reduces problems related to soil management and conservation [22]. One of the obstacles to using the no-tillage strategy is soil compaction, which can be solved through crop rotation when using a deep and vigorous root system with species that can reduce the above mentioned problem. [23, 24].

In the practice of crop rotation, species with a root system that provides greater depth in the soil and decompaction is used. Legumes are recommended, as they have the potential to add nitrogen, and sequestration of carbon in the soil, which will increase production of culture [25, 26].

Generally speaking, crop rotation is the planned and orderly alternation of different crops in a given period of time and in the same area, so that the plant species is not repeated in the same place in a period of time less than one year, following the ordering of crops, as opposed to the succession of crops, which is based on the sequence of crops in the same year, using only two crops, for example, the corn/soybean succession [22].

Even with the practice of crop rotation, it is essential to properly manage the production

system, through practices that aim to take care of the system as a whole to achieve greater productivity. The benefits of crop rotation are exclusively: the maintenance of the physical, chemical and biological conditions of the soil; alternation of extraction pattern and nutrient cycling through the use of species with different root systems, improvement in soil nutritional conditions; stability of grain yield, due to the break in the pest and disease cycle; weed reduction [25, 27, 28].

It is noteworthy that crop rotation is a sustainable and important practice for the control of diseases in crops, as a preventive method of control, in addition to being a practice that can help the plant reach its physiological potential, reaching higher yields, and thus, increase food production in the agricultural sector.

### 2.3 Sustainable Disease Management

The use of alternative methods in the control of phytopathogens, such as biological control, which can be carried out with the use of microbial agents and/or plant extracts. They can offer lower effective cost, ease of application, ication, in addition to leaving no residues in the environment. This offers sustainable culture management because its mechanisms of action are based on antagonistic relationships between the control agent and the phytopathogens, such as competition, predation, mutualism, parasitism and resistance induction in the host plant [23,18,10,9,17,29].

Biological control agents favor the control of diseases through their insecticide, fungicide, herbicide and nematocidal potential, which offers protection to plants against the attack of pathogenic organisms. Some studies have also demonstrated the direct fungitoxic action, by inducing natural plant defenses, indicating the presence of compounds with eliciting characteristics [10, 12, 17, 30]. Biological fungicides based on plant extracts provide benefits by favoring the development of the crop in a sustainable manner and guaranteeing productivity through disease control [9,17, 29].

These control methods, such as sustainable management, linked to crop rotation, offer greater disease control, as these practices are usually carried out in the presence of pests and crop rotation is a way to prevent disease in the crop.

### 2.4 Culture Rotation and Disease Management

Crop rotation has many benefits in production systems, in addition to being a system conservation practice, crop rotation aims at sustainability, production in a sustainable way.

Of the benefits presented, it is worth highlighting the control of weeds, pests and diseases, due to the breaking of crop cycles, making environments unfavorable to the development of pests and diseases, and the emergence of resistant weeds, demonstrating the importance of crop rotation in management sustainable [27, 24].

In disease control, according to Reis, Casa and Bianchin [31], crop rotation is related to the management of crop residues and the period necessary for their mineralization, as crop residues are shelter and food for phytopathogens during their saprophytic phase, and when using crop rotation, their populations are affected, ensuring better control of the pathogen.

Crop rotation acts in food suppression, eliminating the nutritional source of the phytopathogen leading to microbial competition and starvation, killing your food, and also acts in soil suppression or increasing the activity of antagonistic microorganisms in the soil, creating microbial competition and an antagonist selection in the system for creating ideal conditions to increase the antagonist population [31].

Thus, the phytopathogen is suppressed, hindering its establishment and development in the culture, and in cultural remains, favoring its control, and preventing the disease from occurring in the culture [32, 29].

However, disease control is the sum of all control methods, and crop rotation is an essential practice for disease control, as well as being important for soil conservation, crop development, and other aspects, providing a sustainable production system, and benefiting the crop by managing the disease in the crop.

### 3. CONCLUSION

The productivity of a crop depends on many production factors, and crop management is essential to ensure plant development. For this reason, disease control is important in the production system to protect and prevent

diseases from damaging the crop, and fewer productions.

Crop rotation comes as a sustainable practice to improve disease control, by breaking crop cycles, providing unfavorable environments for the development of phytopathogens, helping to control diseases and enabling increased crop productivity.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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