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CORN CULTURE: FROM THE FIRST RECORDS TO HARVESTING AND STORAGE

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Abstract

The culture of corn (*Zea mays* L.) has great economic importance, as corn is used in different ways and cultures, ranging from animal feed to high-technology industry. For example, the use of corn grain the animals feed represents the majority of consumption of this cereal. The objective of this literature review is to report on the emergence of corn, its morphology, harvesting and storage of this crop. This study took place in 2023 and used different studies as a basis to develop this review. In this review, we summarize that corn cultivation in both states and countries has been growing and so has its production demand. However, corn-based products make people look for more knowledge about this crop, as information is still very scarce, and it makes farmers look for more information every day, as this crop is growing in demand both production and commercialization in different states and municipalities.

Keywords: *Zea mays* L.; production; management; benefit.

A CULTURA DO MILHO: DOS PRIMEIROS REGISTROS A COLHEITA

Resumo

A cultura do milho (*Zea mays* L.) tem grande importância econômica, pois o milho é utilizado de diversas formas e culturas, vai desde a alimentação animal até a indústria de alta tecnologia. Por exemplo, o uso do milho em grão como alimentação animal representa a maior parte do consumo desse cereal. O objetivo desta revisão de literatura e relatar desde o surgimento do milho, sua morfologia, colheita chegando até o armazenamento desta cultura. Esse estudo ocorreu no ano de 2023 e utilizou diferentes estudos como base para desenvolver esta revisão. Nesta revisão, resumimos que a cultura do milho em ambos os estados e países vem crescendo e a sua demanda de produção também. Não obstante, produtos à base de milho, faz com que se procure maior conhecimento sobre essa cultura, já que as informações ainda são muito escassas, e faz com que os

agricultores busquem cada dia mais informações, pois está cultura vem crescendo a procura tanto a produção como a comercialização em diferentes estados e munícipios.

Palavras-chave: *Zea mays* L.; produção; manejo; beneficiamento.

Introduction

Corn (*Zea mays* L.) has been cultivated since 5000 BC and the oldest remains of cobs are dated 7 thousand years ago, this crop is considered one of the main foods on the American continent, its name comes from the Greek and means "seed or grain" (Miranda *et al.*, 2021). This culture originates from the American continent, more precisely found on small islands near the coast of Mexico, in the Gulf of Mexico (Miranda *et al.*, 2021).

Over the centuries, it has been a staple of several important civilizations, and the Olmecs, Mayans, Aztecs, and Incas have revered the grain, both artistically and religiously (Vain, 2007; Vasil, 2008; Ramkumar *et al.* 2020). American Indians planted the same plants in mounds, using a complex system that changed the species planted according to their use. This method was replaced by monovarietal plantations (Rohrig, 2022).

With the great navigations and the beginning of the colonization process in America, corn expanded to other parts of the world, today it is cultivated and consumed on all continents and its production is second only to wheat and rice (Rohrig, 2022). In Brazil, corn has been cultivated since before the arrival of Europeans (Miranda *et al.*, 2021).

The Indians, especially the Guarani, had cereal as the main ingredient in their diet, but with the arrival of the Portuguese, consumption increased and the appearance of corn-based products were incorporated into Brazilian eating habits (Miranda *et al.*, 2021).

Its popularity began when the first Europeans discovered its existence: explorers spoke of "a type of grain" that they called corn, with a good flavor when cooked dry and like flour (Pinheiro *et al.*, 2021).

In America, corn is known by different names: corn, choclo, jojoto, corn, mays, and elote (ABIMILHO, 2021). It should be noted that there are different types of corn, such as dented, hard, soft or floury, sweet and popcorn. Today we find approximately 150 species of corn, with great diversity in color and shape of the grains (Pinheiro *et al.*, 2021).

The economic importance of corn is characterized by the different ways in which it is used, ranging from animal feed to high-technology industry (Shinkai *et al.* 2020). In reality, the use of corn grain as animal feed represents the majority of consumption of this cereal (Coêlho, 2021). In the United States, around 50% is allocated to this purpose, while in Brazil it varies from 60 to 80%, depending on the source of the estimate and from year to year (Eicholz *et al.*, 2020). Given the above, this literature review aims to report on the emergence of corn, its morphology, harvesting and storage of this crop.

Material and Method

The study of this bibliographic review was carried out in the year 2024, which includes consulting scientific publications that allow describing the importance of corn cultivation, its origin, production, management, harvesting and storage. According to (Pereira *et al.*, 2019), when preparing a literature review, the results of some discovery, experiment carried out, description of a case, description of some phenomenon that occurred are being reported.

Results and Discussion

Brazil is the second largest corn exporter on the planet, but this was not always the case: historically, the country's corn was grown mainly for domestic supply (Silva *et al.*, 2021). Scenarios began to change in the 2011/2012 harvest, showing overproduction (USDA, 2022). With each subsequent cycle, the share of Brazilian corn increased (Contini *et al.*, 2019).

Currently playing an important role as a food supplier, especially during the low season in the United States. Brazil exported more than 130 thousand tons of grains in April 2021, according to the Foreign Trade Secretariat of the Ministry of Economy, in 2020 Brazil exported grains to 90 countries, including: Japan, Iran, Vietnam, South Korea and Egypt (Digital, 2021).

Morphology, Growth and Development

The growth and development of a corn plant is divided into two major stages: **I)** vegetative; **II)** and reproductive (Pionner, 2018). Corn plants develop leaves based on their relative maturity and growing environment (Basen *et al.*, 2020). Hybrids can vary the number of leaves according to their development cycle, with an average of 15 to 23 fully developed leaves at maturity (Pionner, 2018).

The main components of a corn seedling are:

- ✓ Seed Envelope (pericarp): Composed of 5 to 6% of the total weight of the seed;
- ✓ Endosperm (starch): Makes up 83% of the weight of the total seed and is composed of an outer layer of rigid starch surrounding a core of malleable inner starch;
- ✓ Embryo (germ): Makes up 11% of the total weight of the seed and consists of a plumule (embryonic plant) and the scutellum (cotyledon or seed leaf);
- ✓ Coleoptile: Protective sheath that surrounds the growth point;
- ✓ Mesocotyl: First internode or part of the culm between the cotyledon and the first node;
- ✓ Radicle: Radicella or primary root;
- ✓ Coleorrhiza: Protective sheath that surrounds the radicle.

Ecophysiology

As tropical plants, corn requires heat and water in its nutrient cycle to develop and production is satisfactory and offers great returns (Alves *et al.*, 2022). The process of photosynthesis, respiration, transpiration and evaporation occur as a direct function of the energy available in the environment, often referred to as heated, while growing, photoassimilated development and translocation and soil water use efficiency, having the most pronounced effect under conditions of high temperature, where there was a high rate of evapotranspiration (Cabral *et al.*, 2020).

Temperature is one of the most important and decisive production factors for corn development, although water and other climatic components directly influence this process (Alves *et al.*, 2022). Areas with average daily summer temperatures below 19°C and average night temperatures below 12.8°C are not recommended for this species. Soil temperatures below 10°C and above 42°C significantly impair seed germination, while soil temperatures between 25°C and 30°C provide the best conditions to trigger this process (Cabral *et al.*, 2020).

Environment and Soil Fertility

Soil preparation is an activity designed to provide conditions for seed germination and the adequate establishment of the corn root system (Moreno, 2019). Not only is soil preparation important, but environmental conditions and fertility are some of the crucial factors for achieving good corn productivity (Gao *et al.*, 2020).

When talking about soil fertility where we want to work, we must always take crop rotation into consideration, as rotation is a recommended practice, having beneficial effects for the crop in question, not only as an increase in productivity but also in the quality of the soil where the crop is intended to be cultivated and developed (Gao *et al.*, 2020).

Corn, when cultivated in a rotation system with other crops, even intercropped, can obtain benefits in terms of fertility, both chemically, physically and biologically, as if it is in soils with low fertility it becomes a problem, especially for corn crops, as which is a crop that has a more intense development, short cycle and requires a higher and faster phosphorus rate than other perennial crops (Coulter, 2019). Therefore, the way considered to be one of the main ways of absorbing the phosphate ion is through the diffusion process, where the ion reaches the rhizosphere more easily, however it has the characteristic of presenting low values (Sheteiwy *et al.*, 2019).

Within this context Fernandes, Fonseca e Braz (2013) explain that the most tropical soils have predominantly acidic pH and little available phosphorus, constituting a factor that limits production and for the cultivation of corn it is the preparation of the soil, ideally it should be rich in organic matter and have a pH between 5.5 and 6.8.

Regarding environmental conditions, climate change has evoked variations in temperature, precipitation and atmospheric conditions and exposed plants to adverse and extreme climatic conditions that negatively affect morphological, developmental, cellular and molecular processes in plants (Raza *et al.* 2019).

Unfavorable environmental conditions, such as high temperature and increased CO_2, influence the yield of plants, which are very sensitive to climate and change due to their long lifespan which makes it difficult to adapt to changes in environmental conditions (Dusenge; Duarte; Way, 2019). According to some experts, the impact of climate change on plant development is attributed to altered photosynthetic carbon assimilation mechanisms (Dutta *et al.*, 2020).

Furthermore, water stress induced due to changes in climatic conditions severely hampers stomatal conductance, water relations of plants, in which assimilation of CO_2 and photosynthetic pigments leading to reduced productivity in plants (Dusenge; Duarte; Way, 2019).

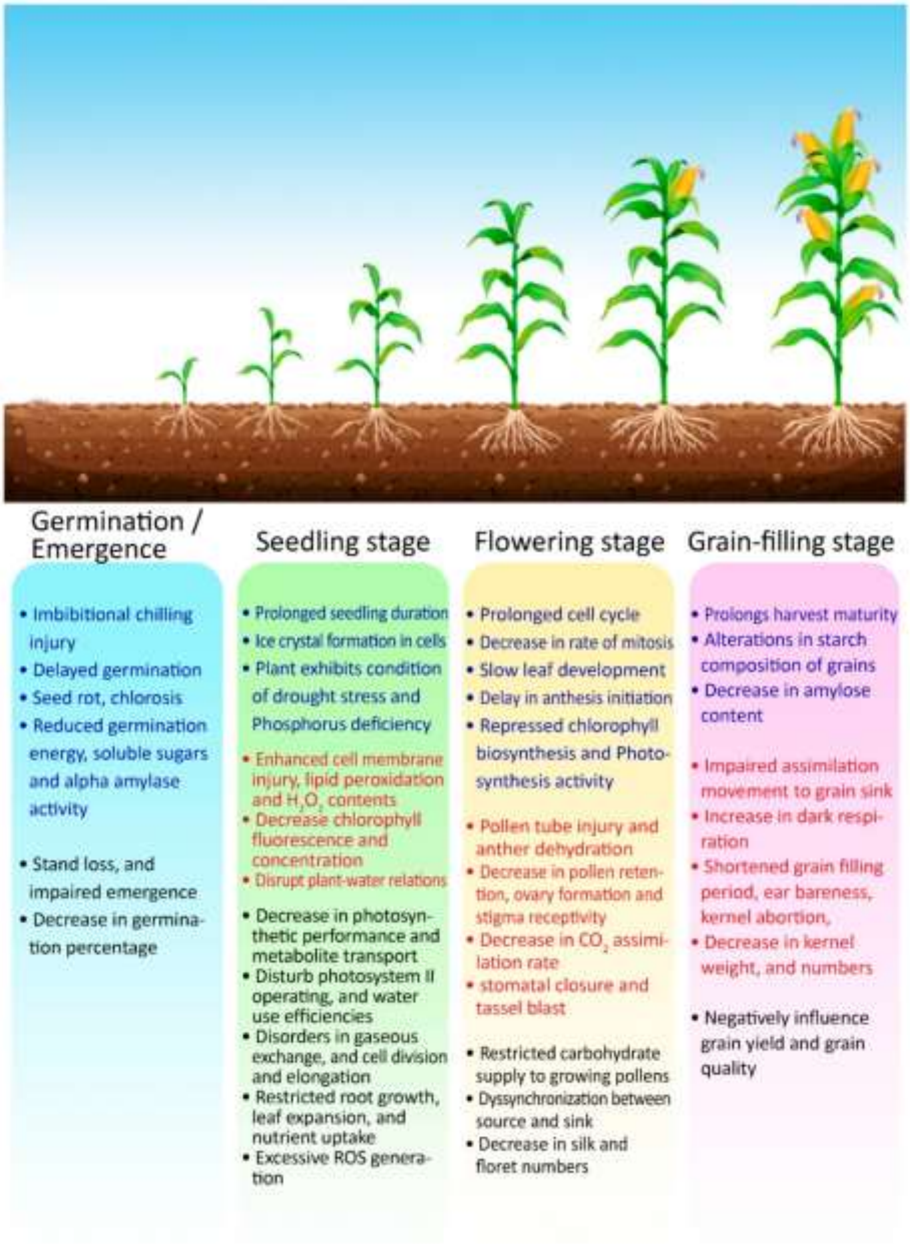
Temperature variation caused by climate can affect crop plants generally experience different biotic and abiotic stresses simultaneously, which cause many morphological and physiological disturbances, resulting in stunted plant growth and reduced grain yield. Temperatures above the limit for various metabolic, biochemical and physiological processes result in an imbalance in these activities and activate the plant's innate defense system.

Temperature extremes alter the photosynthetic process, damage biological membranes, affect nutrient absorption and limit the functioning of several enzymes in corn plants (Dutta *et al.*, 2020). Stunted growth and low photosynthetic rates cause harm to the overall performance of corn (Wang *et al.*, 2019).

Low temperature stress in grain filling can also alter the composition of the starch in the grain, reducing the amylose content, ultimately decreasing the water solubility and swelling power of the starch and increasing gelatinization temperatures (Rafique, 2019). Temperatures below 15°C during the late reproductive stage reduce the activities of the photosynthetic apparatus, as well as the rates of sucrose phosphate synthase, phosphoenolpyruvate carboxylase and sucrose synthase (Zafar; Patil; Uzair, 2020).

It tends to destabilize the assimilation process, resulting in impaired grain quality with lower quality components and poor physical texture of the grain (Dusenge; Duarte; Way, 2019). Collectively, low temperature stress reduces germination percentage, growth rate, and photosynthetic rate, resulting in low yield (Hussain *et al.*, 2020). A schematic representation of the various effects and mechanisms of thermal and cold stresses is summarized in figure 1.

Figure 1. Overview of the impacts of cold and heat stress on the critical growth phases of the corn crop. Heat stress impacts are marked by red fonts, while blue fonts indicate cold stress impacts. Combined impacts (which can be caused by both voltages) are marked in black fonts.



Source: (Chaudhry, 2021).

Crop management

Regarding prevention and corn harvest management, it is important to highlight that it involves a series of measures that must be followed, such as: avoiding planting close to disease-prone species; apply seed treatments; diversify and rotate corn varieties; and apply pesticides based on the occurrence of diseases and pests (Torres, 2022).

Several alternatives can be used, but the way that has been widely used today by producers for corn cultivation and chemical control over diseases, which has demonstrated a certain effectiveness of fungicides in controlling diseases that directly affect the leaf area of the plant reducing the damage caused by such diseases in corn (Nasar *et al.*, 2022). A practice that is frequently recommended is the treatment of seeds with substances that provide protection to both the seed and the seedling, either through the direct action of the substance in contact with the pests, leading to their death, or through the action of repelling such pests. pests (Torres, 2022).

According to (Nasar *et al.*, 2022), they report that some fungicides, in addition to helping to combat diseases, also help to stimulate plant growth, resulting in more effective levels of water and nitrogen use by plants, in addition to retention of chlorophyll, delay in leaf senescence, called “green effect”, increase in antioxidant activities and, therefore, increase in productivity.

Harvesting, drying, processing and storage

Harvest planning begins even before the crops are planted, initially, it is important to divide the planting area into plots. This will facilitate the movement of the machine and the production process. When planning a corn harvest, it is necessary to consider points such as: moisture of the harvested corn; size of the cultivated area; corn cycle; climate conditions; harvest window; available machinery and labor; corn harvest time; distance between plots and drying/storage locations; drying and storage capacity (Silva *et al.*, 2021). From agricultural planning, you must know the destination of the product you will harvest. Evaluate whether the planted corn will be sold for silage, cooperatives, or dried and stored for future sale (Borges; Porciuncula, 2020).

The ideal type of storage is defined by the need to store grains or ears of corn. Furthermore, the technical level of storage will be determined according to the quantity to be stored and the availability of equipment resources used to build and constitute the storage unit. If you want to store grains, they can be in bulk, in silos or in bulk or in bags, in warehouses. If you want to save the cobs, you can store them in warehouses (Tang *et al.*, 2020).

Firstly, we have the pre-harvest factors, which are: variety, natural drying of the field, climatic conditions, harvest point and type of harvest. The second stage is cleaning, which removes impurities, cultural residues and cracked, broken or charred grains from the batch to be stored, with or without drying after Harvest (Yang *et al.*, 2021)

Processing is one of the steps in obtaining high-quality seeds in a seed company. The maximum quality of a batch of seeds is a direct function of the production conditions in the field, that is, the seeds are obtained in the field. However, seeds contain undesirable substances after harvest, which must be removed to facilitate sowing, drying and storage, as well as to prevent weed seeds from being transported to other áreas (Borges; Porciuncula, 2020).

Hence the importance of processing to obtain high quality seeds. All operations are processed, including sending seeds, receiving from the seed handling unit (UBS) to packaging and distribution (Porciuncula, 2020).

Conclusion

According to this review, it was possible to gather important characteristics for corn cultivation, whether they are more general characteristics, popularly disseminated among farmers, or more peculiar ones, but of fundamental importance for the development of the culture. However, information is still scarce, which makes people look for more information every day, as it is a culture that has been growing both its production and demand in several states and municipalities.

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