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EFFECTS OF SALT STRESS ON BASIL: A BIBLIOGRAPHIC REVIEW

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RESUMO:
O manjericão é uma espécie de elevado potencial de exploração. Contudo, sua produção em regiões semiáridas é comprometida pela presença dos sais contidos no solo e na água utilizada na irrigação. Assim, objetivou-se mostrar as recentes descobertas a respeito dos efeitos da salinidade na cultura do manjericão. aprofundando o conhecimento a partir da análise dessas estruturas por meio de levantamento bibliográfico. Os dados apontam que a salinidade está entre os fatores ambientais que mais limitam o crescimento e desenvolvimento das plantas de manjericão, além de ocasionar danos nos processos fotossintéticos, na composição mineral e na absorção de nutrientes essenciais.
Palavras-chave: Hortaliça; Estresse abiótico; *Ocimum basilicum* L.

ABSTRACT:
Basil is a species with high exploration potential. However, its production in semi-arid regions is compromised by the presence of salts contained in the soil and in the water used for irrigation. Thus, the objective was to show the recent discoveries regarding the effects of salinity in the basil crop. deepening knowledge from the analysis of these structures through bibliographical survey. Data indicate that salinity is among the environmental factors that most limit the growth and development of basil plants, in addition to causing damage to photosynthetic processes, mineral composition and absorption of essential nutrients.
Keywords: Vegetable; Abiotic stress; *Ocimum basilicum* L.

1. INTRODUCTION

Salinization is a problem that affects many irrigated areas, mainly due to the use of water with restricted use, which has high levels of salts (SILVA & DIAS, 2020). It has been reported that the equivalent of 5 billion hectares of salinized soil exists on the entire planet, and in the case of Brazil, 25% of its area used for agricultural crops is affected by this obstacle (PEDROTTI et al., 2015). Thus, agricultural crops that suffer from saline stress tend to lead to reduced growth and yield, affecting plant photosynthesis as well as mineral composition and nutrient absorption, also causing imbalance or ionic toxicity due to the exorbitant presence of Na^+ (MISBAH et al., 2022).

High salinity levels affect 7% of the total land areas on the planet, where damage

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generates economic loss of approximately US$ 27.2 billion per year (YANG & SUN, 2020), in addition to causing damage in about 30% of areas arable globally by mid-2050 (HASNAIN et al., 2022). In this sense, salt stress affects plants in different ways, activating their physiological and biochemical mechanisms that modify their morphology, anatomy, water relations, protein synthesis, primary and secondary metabolism, as well as the response of antioxidant metabolism (EL SABAGH et al., 2020).

Several studies have been developed regarding the effect of salinity on basil cultivation (NOBREGA et al., 2022). *Ocimum basilicum* L., popularly known as basil, is an economically important species with high aromatic and medicinal potential, used abundantly in essential oil extraction and cosmetic and pharmaceutical industries (SILVA et al., 2019). However, in the presence of salt stress, this crop ends up limiting its productive potential.

Therefore, the objective of this work is to show the recent discoveries regarding the effects of salinity in the basil culture (*Ocimum basilicum* L.), deepening the knowledge from the analysis of these structures through a bibliographic survey.

2. METHODOLOGY

2.1 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. The qualitative approach is the one in which quality criteria are attributed in the choice of works and bibliographic sources, without the need to present data, numbers and/or statistics, only in a descriptive way (GIL, 2008).

Descriptive research is characterized by seeking a description, analysis and verification of facts and phenomena, through a detailed investigation aimed at identifying the causes and consequences of the topic addressed (PRODANOV & FREITAS, 2013).

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) describe 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 given source of data, carrying out, therefore, a wide

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research where the data are selected according to the author's opinion.

2.2 Technical procedures

A database of sites and queries was used through digital libraries: Scientific Electronic Library Online (SCIELO), Periodical 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: "*Ocimum basilicum* L.", "Salinity", "Vegetables", "Basil", "Salt stress" 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 effects of salinity on basil. The information collected was through consultation in publications of reference authors in the study area with subsequent critical reading on the subject.

3. RESULTS

3.1 The culture of basil

Basil (*Ocimum basilicum* L.) is a plant considered annual or perennial, originating in Southeast Asia and Central Africa (SRIVASTAVA et al., 2018), with emergence in Brazil through immigrants from Italy. There are reports of the existence of about 150 species of *Ocimum* on the planet, and among these, 60 species are inserted in Brazil (ZAGOTO et al., 2022). It is a plant that presents great diversity, given the size of the plant constituents, color of the leaves, chemical composition and yield of the oil that has a high concentration of linalool (VARGA et al., 2017).

It has a height that varies between 0.30 and 1.00 m, with the presence of a woody or sub-woody stem, with a variation in the colors of the flowers depending on the genotype used, with an average length of 1.0 cm and the presence of 6 to 100 flowers in the inflorescence with orange pollen, not tolerating low temperatures and frost, with an ideal temperature of 15 to 25°C (FLORA OF BRAZIL, 2020).

Is an oleaginous plant of high importance, used for nutraceutical purposes and in cooking, belonging to the *Lamiaceae* family, and occurring in tropical and subtropical regions (ALDARKAZALI et al., 2019), also presenting an essential oil used in dental products and perfumery (ABSAR, 2016). The most significant varieties of basil stand out in sweet, purple, lemon, cinnamon and aniseed basil (SHAHRAJABIAN et al., 2020).

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Basil has repellent properties, acting against pathogens, with nematicidal, antimicrobial, fungistatic and insecticidal effects (KNAUS et al., 2020). It is therefore considered an essential ingredient in almost all countries and cultures, and can be grown with or without the presence of soil as a substrate (REHMAN et al., 2016). As a result, its cultivation has been increasing globally, with a worldwide increase in the volume of essential oil in recent decades that reaches over 100 tons, consequently increasing its market value (JAKOVLJEVIĆ et al., 2022), also presenting antiseptic activities, analgesic, anti-ulcer, antioxidant, as well as anti-inflammatory and antituberculous properties that increase the richness of this plant.

In order to seek a high yield and quality of basil oil, it is necessary to observe important factors during cultivation and harvest, since when these factors are added, the genetic load of the vegetable can influence the composition of the essential oil (VELOSO et al., 2014). Several scientific works prove that the variation between the substances found in basil oil varies according to the genotype used for cultivation (REZAEI et al., 2021). Due to these varied possibilities of using this crop, industries have become interested in basil, in order to develop valuable products (ZAGOTO et al., 2022). However, some obstacles hamper the possibility of a good development of the basil plant, as is the case with salinity, which affects its development when exposed to saline stress.

3.2 salinity: effects on soil and plant

Soil is an indispensable resource as it provides a means of feeding the high and continuing global population, which could reach more than 9.8 billion by the year 2050 (UNITED NATIONS, 2020). However, the excess of salts present in its structure makes it saline, harming agricultural crops, environmental health and financial well-being (DIAZ et al., 2021). The accumulation of salts in the soil and consequently in the root zone of plants has negative consequences, such as loss of fertility and changes in their physical, chemical and biological properties (FU et al., 2020).

Soil salinization encompasses saline soils, in which they present EC values (from the satiated mass extract) >4 dS/m, ESP <15 and pH <8.5, alkaline soils, which present corresponding values <4 dS/m (CE), >15 (ESP) and >8.5 (pH), and finally, saline-alkaline soils (SEIFI et al., 2020). High levels of salinization result in a decrease in available resources in the soil, which can become a serious problem in the long term (BREVIK et al., 2015).

Salinity is caused by two main aspects, one being by man (secondary salinization), in which the use of water with quality restriction for irrigation purposes in agricultural crops in times of drought becomes the main attribute that causes the salinity of the soil, combined with the

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lack of good drainage (PENA et al., 2020), and there are natural ones (primary salinization), in which physical or chemical weathering of minerals and seawater intrusion become the main factors that cause such an effect on the soil (RAMOS et al., 2020).

Across the globe, saline soil tends to cause annual agricultural losses of up to U$ 27,3 billion, as it hinders seed germination and directly influences agricultural yield and soil and water quality, especially in arid and semi-arid regions, causing land degradation (SHAHID et al., 2018). In addition, high concentrations of salts modify plant development due to the effect of osmotic stress, which limit root growth (GORJI et al., 2017).

Based on the data expressed, it is noted that plants tend to face abundant abiotic stress conditions in their development, in which saline stress appears as a means of delaying this progress and even causing their death (SAFDAR et al., 2019). The excess of salts in the root system induces saline stress in plants, which consequently leads to stomatal closure and reduced gas exchange, reduced water absorption, leaf expansion and leads the plant tissue to the ionic effect, impairing photosynthesis, biosynthesis, growth and productive yield of the plant (SILVA et al., 2018).

The initial symptoms associated with salt stress in plants begin with the roots due to osmotic stress and accumulation of phytotoxic ions, inducing, over time, ionic toxicity due to the lack of nutrients in the cytosol (HERNÁNDEZ et al., 2019). Thus, these salinity responses help contribute to harmful effects on plants, despite the existence of plants that are resistant to high salt concentrations and tend to survive in places with high saline concentrations (HERNÁNDEZ et al., 2019).

Furthermore, the plant tends to enter into a transpiration flow and subsequently damage the cells present in the leaves that transpire, which reduces their growth more quickly (PARIHAR et al., 2015). Thus, such mentioned effects originate a two-phase growth response to salinity, attributed by Munns (2005) (Figure 1).

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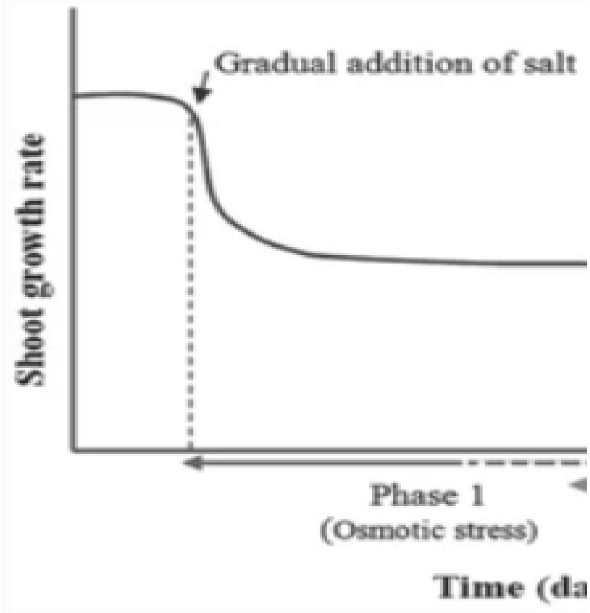

Figure 1. Overview of the two-phase growth response to salinity for plant differing in salt sensitivity (adopted from MUNNS 2005).

The first phase results in the effect of salt outside the plant, that is, still present in the soil, salt decreases leaf growth and, to a lesser extent, root growth (MUNNS, 2005). In addition, Na+ and Cl- do not accumulate in developing tissues in concentrations that hinder plant growth (HERNÁNDEZ et al., 2019).

In turn, in the second phase, it is possible to observe the toxic effect of salt inside the plant, being absorbed and concentrated in the old leaves through continuous transport,
resulting in plant transpiration and causing high concentrations of Na+ and Cl- , generating the death of leaves (HERNÁNDEZ et al., 2019).

3.3 Salt stress in basil

Like most cultivated plants, basil is sensitive to different abiotic stresses, especially salinity, which, when affected by saline stress, affects several important functions in the plant, altering its morphology and physiology, including the growth rate, relative and transpiration rate, water relations and water use efficiency, as well as nutrient absorption, stomatal conductivity, photosynthesis and senescence (CALISKAN et al., 2017).

Some of the latest advances in the subject address aspects related to the use of attenuating agents as a way of mitigating saline stress in basil, since, when in contact with this phenomenon, the plant presents disturbances in its entire structure, considerably reducing the essential processes of the plant (MASOUDNIARAGH et al., 2021).

However, as the genus *Ocimum* has more than 30 different species, there is a lack of information regarding the action of salts on the development of species, in view of the different intrinsic mechanisms that confer tolerance to salt stress (BARBIERI, 2012).

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Trevizan et al. (2020), when investigating the germination and initial growth of basil seedlings subjected to saline stress, found that after stress induction in plants, there was a high rate of damage to seed germination and initial growth of seedlings, with inhibition at 100% in the presence of the lowest osmotic potential used in the study (-1.2 Mpa).

Although it is clear that salt stress impairs basil production, there is little knowledge related to how salinity intervenes in the polyphenolic composition of leaves as well as influences specific polyphenolics (BEKHRADI et al., 2015).

It is noted that more specific studies are needed in this area. In this sense, it is essential to understand how basil responds to different levels of soil salinity, as well as to develop mechanisms to mitigate the harmful effects of salt stress.

3.4 Future perspectives

It is understood that further research regarding salt stress in basil should be taken into account. However, in recent years, the number of researches that address the effects of saline stress on basil has increased considerably, in order to search for genes that can be used in the search for resistant genotypes. Thus, obtaining species resistant to saline stress is one of the objectives of breeders in order to obtain a salt-tolerant plant.

4. FINAL CONSIDERATIONS

Salinity is one of the main factors that limits the geographic distribution of plants and negatively affects the productive yield and quality of basil.

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