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Impact of Soil Texture on the Architecture of the Root System in Stachys multicaulis Benth Under Stress from Salinity and Drought

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ABSTRACT

Background and Goals : One of the most crucial mechanisms for plant adaptation is the alteration of the root system's architecture in response to environmental stress. In terms of root morphophysiological changes, salinity and drought stress are the two main environmental stresses that plants should be able to withstand. Thus, this study's objective was an evaluation.of the root morpho-physiological alteration caused by environmental stress in the Iranian medicinal endemic Stachys multicaulis.Supplies and Procedures: Three-day watering intervals and a set of salinity (0, 5 and 25 ds mG1) were employed in three distinct soil textures in pots as part of the drought treatments. The design was fully randomized. Plant root morphological changes under stress in three different soil textures were investigated over time.

Keywords : Drought, salinity, soil texture, root system, Stachys multicaulis.

INTRODUCTION

In many parts of the world, drought stress restricts plant growth and development1,2, which is a major factor influencing the distribution and productivity of terrestrial vegetation3.In addition to the scarcity of water, salt is a significant abiotic stressor that impacts roughly 7% of the planet's land area.4, 5. As a result, a wide variety of abiotic and biotic stress conditions can affect plants, and a major environmental danger that can restrict plant growth is salt and drought stress6, 7. But the first portion of a plant to be impacted by stress is the root8,9. Since roots are where plants initially experience the stress of drought, it is possible that roots might detect and react to the stress condition10. Because environmental pressures fluctuate in kind and duration, Depending on the type of plant and the soil, numerous things can happen to the roots of the plant. Low salinity stimulates a number of processes in plants that help them better tolerate stress and deal with environmental stresses11,12,13, but excessive salinity can negatively impact numerous biological processes and stunt plant growth.The majority of research in recent years has concentrated on root architecture and how it responds to drought stress12,14,15. The spatial arrangement of the root system and root morphology16 is referred to as root architecture, which is a combination of root morphological and physiological adaptation.A plant's root system design binds it to the soil, influences how it absorbs water and nutrients from the soil, and is crucial to the health of the plant. Modifications to the root There is a strong correlation between environmental perturbations and architecture11. However, plants have the ability to modify the design and distribution of their root systems in response to changing environmental conditions11; this adaptation of the root system is essential to the plant's survival. To better understand a plant's ability to naturally adapt to a certain environment, differences in root architecture are particularly interesting19. The availability of water and the composition of the soil both affect the root architectural system20.The morphological and physiological changes that certain plant species undergo in response to these two primary environmental stresses in various soil types, however, are still largely unknown.

MATERIALS AND METHODS

on the spring and summer of 2017, the study was carried out on an open field in the Iranian province of Isfahan, namely in the Tiran and Karvan region. Additionally, the laboratory portion was carried out at Tehran University.In short, Iran's wild indigenous plant is called Stachys multicaulis22. a green bush with a basic trichome covering that grows to a height of 20–40 cm (Fig. 1). The significance of the plant for medical purposes or other uses.Study of the plant habitat in the soil: An individual plant stand identification survey was conducted in Iran's rangelands.The plant's environment was then sampled for soil at two distinct depths (0–15 and 15–50 cm). The soil's chemical and physical characteristics comprised sand, silt, pH, EC, OM, N, P, and K

Soil preparation for planting : Samples of the soil were collected for pot culture. The percentage of clay, silt, and sand in the habitat soil was 24, 32, and 42%, respectively. There were three distinct soil textures that created based on variations in the composition of the soil, such as the proportion of sand, silt, and clay23 (Table 2). As a result, three soil textures light, medium, and heavy were made by hand-adding sand and clay.Plant components: Plant scion was grown in pots as a result of the S. multicaulis seeds' poor germination. Plant scions were harvested from the field in the early spring of 2016 and moved to the home garden to be grown in pots for this purpose.Applying stress due to salinity and water: A set of salinity (five different NaCl values, ranging from 0 to 25 ds mG1), drought Four replicates and five treatment levels three levels containing irrigation times of three, six, nine, twelve, and fifteen days as well as three distinct soil textures light, medium, and heavy were created in a completely randomized manner. Drought and salinity treatments were applied about 35 days after culture. Measuring root morpho-physiology: Following a 60-day period, measurements were made of the morpho-physiological characteristics of the plant roots, including root length, volume, moisture content, density, and general root production. Root sampling and biomass measurement were carried out in accordance with research 20. Lastly, one-way ANOVA and the post hoc test (Duncan) were used to examine the data that was gathered.

RESULTS

All measurements of the root characteristics under salinity and drought stress for various soil textures showed a substantial variation. The impact of soil Additionally noteworthy was the texturing on the root architecture. When under drought stress, heavy soil texture exhibits the greatest change in root length, whereas light soil texture exhibits the greatest change in salinity stress (Table 3). Without taking into account the texture of the soil, drought stress caused the largest change in plant root length. The length of the root was affected differently depending on the salinity and intensity of the drought (Fig. 2). Even though high stress caused some characteristics, including root length, to rise, the overall volume of the plant root dropped.Across the three soil textures, this factor was almost the same. The The majority of the variation in root dry weight occurred in heavy soil texture under varying salinity and drought conditions. For light, the lowest root weight occurred.Changes under stress were influenced by the texture of the soil (Table 4). The root moisture content of S. multicaulis reduced with varying salinity and drought treatments, according to the results. The findings also showed that plants were resilient to environmental stress and could maintain their hydration in extreme salt and drought conditions (Fig. 4). The investigated root plant species' moisture content is similarly impacted by environmental dryness and salinity stress.

DISCUSSION

An essential plant response to nutrient availability is root architecture alteration. Drought and salinity-induced osmotic stress can have an impact on plant root systems.Because of the severe drought and rising salinity issues, there is an increasing need to produce crops with a higher salt tolerance. Regarding this, the main plant components that are exposed to environmental stress and are crucial to the tolerance and productivity of plants are their roots.Plant scientists and crop breeders have made it their main mission to comprehend the processes of drought tolerance and to breed for drought-resistant agricultural plants. Drought-related water stress is still the most important abiotic factor restricting plant growth and development27. In light of the aforementioned, it's critical to understand the mechanism of Under stressful and changing environmental conditions, root architecture changes.Root architecture varies in harsh and dynamic environmental situations.

CONCLUSION

In response to drought and salinity stress, S. multicaulis displayed various morphophysiological alterations in its roots. This plant most likely uses particular root and aria part morpho-physiological treatments to adapt to the tough conditions.Depending on the soil texture, the effects of salinity and drought on the morphophysiological root characteristics differed. This discovery will aid in the effective introduction of S. multicaulis into stressful settings. Plants grown in medium-textured soil performed the worst in conditions of dryness and salinity.

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