MORPHOLOGICAL AND PHYSIOLOGICAL STUDIES ON THE ROLE OF SOME BIOREGULATORS TO REDUCING WATER STRESS IN *THYMUS VULGARIS L.*

By

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B.Sc. Agric. Sc. (Plant Pathology), Ain Shams University, 2007

M.Sc. Agric. Sc. (Agricultural Botany), Ain Shams University, 2012

A thesis submitted in partial fulfillment

Of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Agricultural Sciences

(Agricultural Botany)

Department of Agricultural Botany

Faculty of Agriculture

Ain Shams University

2019

Approval Sheet

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ABSTRACT

Reham El-Sayed Farag Hassan: Morphological and Physiological Studies on The Role of Some Bioregulators to Reducing Water Stress in *Thymus Vulgaris* L, Unpublished Ph.D. Thesis, Department of Agricultural Botany, Faculty of Agriculture, Ain Shams University, 2018.

Two pot experiments were conducted on the 17th and 19th of March of 2015 and 2016 respectively at the Experimental Farm, Faculty of Agriculture, Ain Shams University, Shoubra El-Kheima, Egypt to investigate the effect of foliar application of potassium citrate (KC, 1.63 or 3.26 mM), proline (Pro, 50 or 100 mM), putrescine (Put, 0.1 and 0.2 mM) and distilled water as control on thyme plants (*Thymus vulgaris* L) under water deficit conditions. Two irrigation levels according to the water holding capacity (WHC) were investigated; the well-watered plants were irrigated when the value of field capacity (FC) between 70-80% whereas; the water-stressed plants were irrigated when the value of FC between 30-40%. The results indicated that water stress caused significant ($P \leq 0.05$) decreases in the studied growth parameters including the fresh and dry weights for shoot and root whereas, there was a significant increase in shoot/root dry matter ratio. Moreover water stress induced multiple significant changes in the biochemical constituents including the photosynthetic pigments (Chl a, Chl b, Chl a/b ratio and carotenoids), reactive oxygen species as indicated by increasing the concentration of H_2O_2 and the rate of lipid peroxidation in term of malondialdehyde (MDA), osmolytes (soluble sugars, proline and free amino acids (FAA)), total soluble phenols and phenolic related enzymes (Phenylalanine ammonia-lyase (PAL). Polyphenol oxidase (PPO), and peroxidase (POD)) Furthermore, water deficit caused several changes at the morphological and anatomical levels of the thyme plants.

Water stress induced multiple significant changes in the morpho-anatomical characteristics. Drought stress changed the orientation of

leaves on the stem. The midvein ground tissue differentiated into additional layers of mesophyll toward the lower surface as compared to parenchymatous cells in the unstressed leaves. Water stress led to significant ($P \leq 0.05$) decreases in the cross section area, lamina thickness, palisade tissue area, spongy tissue area, vascular tissue area, number of xylem vessels and xylem diameter in the leaf tissues of thyme plants exposed to the limited irrigation level compared to those that have received sufficient water supply. Whereas, water stress induced significant ($P \leq 0.05$) increase in the cuticle thickness in the water-stressed plants compared to the well-irrigated ones. The results indicated that foliar applications improved these anatomical characteristics. Regarding the stem, Drought causes a well-developed endodermis with noticeable casparian bands on the radial walls as presented compared to the unstressed control. The patches of Collenchyma have more lignified walls as similar as the vascular cylinder cells in stressed plants. Stems under drought stress have small diameter of vascular cylinders, while this cylinders have more lignification. The results indicated that, cross section area, vascular tissue area, xylem area and xylem vessel diameter of the stem of the thyme plants were decreased significantly ($P \leq 0.05$) under water-stressed conditions, these decreases reached 31.8, 29.6, 24.0 and 48.8% in the previous traits respectively compared to those that have received sufficient water supply. The different foliar applications improved the investigated anatomical stem characteristics of thyme plant except xylem vessel diameter with Pro at 50 mM or Put at 0.1 mM which reduced it insignificantly ($P \leq 0.05$) compared to the untreated control. In this regard, the treatment of Put at 0.2 mM gave the highest significant increases in all studied stem anatomical parameters compared to the other foliar treatments.

The foliar applications of KC, (1.63 or 3.26 mM), proline (50 or 100 mM) and putrescine (Put, 0.1 and 0.2 mM) reduced the negative effects of water stress with different responses related to the various studied morphological and biochemical attributes. In this context, it was

observed that the treatments of proline (Pro) at 100 mM and Put at 0.2 mM could be considered the more effective treatments in enhancing and inducing the adaptive mechanism/s to drought stress in thyme plants.

Key words: Thyme, Anatomical studies, Citrate potassium, Proline, Putrescine, Biochemical constituents, Water stress.

ACKNOWLEDGMENT

First and foremost, I would like to thank **"Allah"** the only God Almighty for giving me the patient, strength and ability to finish and complete this research study satisfactorily. Without his blessings, this achievement would not be possible.

Highly appreciation and deepest thanks to **Prof. Dr. Said Awad Shehata,** Emeritus Prof. of plant physiology, Dept. of Agric. Botany, Fac. of Agric. Ain Shams University (main supervisor), for his kindness, continuous encouragement, advice, faithful attitude and support during the preparation of this research study.

I wish to express my deep appreciation and sincere gratitude to **Dr. Ola Hussein Mohamed,** Associate professor of Agricultural Botany, Dept. of Agric. Botany, Ain Shams University, for her excellent guidance, advice and valuable assistance during the performance of this work.

Deepest gratitude is also extended to **all members and colleagues** in Dept. of Agric. Botany, Fac. of Agric., Ain Shams University, for their encouragement.

Special thanks must be extended to my beloved husband **Dr. Mohamed Farag** Associate Professor of Plant Physiology, Dept. of Agric. Botany, Fac. of Agric. Ain Shams University for his supporting encouragement and love.

I would like to express my special thanks to my both sons, **Omar and Abdelrahman;** and **all members of my family** for their continuous help and prayers during this work. Without the support of my own family members, I would never have been able to aspire for this level of education.

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