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Response of Seedling Growth of Wheat and Vegetable Crops (Tomato and Faba bean) to water stress

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استجابة نمو البادرات لنبات القمح ومحاصيل الخضروات (الطماطم والفول) للإجهاد المائي

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Abstract
One of the main abiotic stressors that contributes to the largest losses in crop production worldwide is water deficit. This study was to determine the extent of plant tolerance from varity plant families, namely wheat (*Triticum aestivum* L.), Tomato (*Solanum lycopersicum* L.) and faba bean (*Vicia faba* L.) to water stress. The results showed there was inhibition in dry weight and length of shoot of wheat plants when the replication was treated with irrigation after eight days, while in the fresh weight of weight the inhibition occurred when irrigation was after two days, four days, six days and eight days, while tomato plants water stress had not any effect on shoots and length of roots that the inhibition was clear for the fresh weight when irrigation was after six and eight days. In the bean plant, the inhibition was clear in the shoot length irrigated after eight days and had no effect on length of roots at all treatments. As for the fresh and dry weight of bean plants the inhibition occurred when irrigated after eight days. In future research, assessing the response of three main crops to water stress by studying physiological and biochemical traits is very important as they contribute to specify a biotic tolerance range.

Keywords: Response, Seedling Growth, Solanum Lycopersicum, Triticum Aestivum, Vicia Faba, Water Stress.

الملخص:
أحد أهم مسببات الإجهاد غير الحيوية التي تساهم في أكبر الخسائر في إنتاج المحاصيل في جميع أنحاء العالم هو نقص المياه. أجريت هذه الدراسة لتحديد مدي تحمل النباتات من عائلات مختلفة وهي القمح (*Triticum aestivum* L.)، الطماطم (*Solanum lycopersicum* L.) والفول *Vicia faba* (L.) للإجهاد المائي. أظهرت النتائج وجود تثبيط في طول الساق والوزن الجاف لنبات القمح عند معاملة التكرارات بالري بعد ثمانية أيام، بينما في الوزن الرطب حدث التثبيط عند الري بعد يومين، أربعة أيام، ستة أيام وثمانية أيام، بينما لم يكن للإجهاد المائي لنبات الطماطم تأثير معنوي في طول الساق والجذر إلا أن التثبيط كان واضحاً للوزن الرطب عند الري بعد ستة وثمانية أيام. في نبات الفول كان التثبيط واضحا عند الري بعد ثمانية أيام في طول الساق ولم يكن له تأثير على طول الجذر في جميع المعاملات. أما بالنسبة للوزن الرطب والجاف لنبات الفول فقد حدث التثبيط عند الري بعد ثمانية أيام. في الأبحاث المستقبلية، يعتبر تقييم استجابة المحاصيل الثلاثة الرئيسية للإجهاد المائي من خلال دراسة الخصائص الفسيولوجية والكيميائية أمراً مهماً للغاية، لأنه يساهم في معرفة مدى تحمل هذه المحاصيل للإجهادات اللاحيائية.

الكلمات المفتاحية: الإجهاد المائي، استجابة، الطماطم، القمح، الفول، نمو البادرات.

1. Introduction

In arid and semi-arid environments, the reduction of water quantity and quality is one of the problems that limit production [1]. Water stress is one of the most important environmental elements influencing crop production,

which has a significant impact on food security. [2]. Additionally, it influences conductance of stomatal, photosynthetic pigments, potential of leaf water, and element absorption, particularly a nitrogen and phosphorus [3,4,5]. Agricultural scientists need more studies to know the extent of crop adaptation to climate change in current situation. Tomato *(Solanum lycopersicum L.)*, wheat (*Triticum aestivum L.*) and faba bean (*Vicia faba L.*) are three crops have agricultural and scientific importance.

Tomato (*Solanum lycopersicum L.*) is one of most plants produced and consumed vegetables in the world with the greatest diversity found in the tropical regions of Americas, Australia, Africa and Indo-Pacific [6,7 ,8]. Its fruits contain a large amount of nutrients and rich in vitamins A, C, they also contain carotenoids such as lycopene, which gives vegetables their red color [9,10]. It has the ability to grow in both tropical and subtropical locations, it is susceptible in both biotic and abiotic stressors [10,11]. Stress produced by a shortage of a water (water deficit) is considered one of the most important factors of environmental that affect tomato growth and yield [10,12], while wheat (*Triticum aestivum L.*) is the most important culture in terms of belonging,to the cultivated area, and the rate of production in the world and place an important role in meeting the nutritional needs of human societies [13]. Faba beans considered one of oldest crops in the world, it contains a high percentage contant of protein (20 – 30%), it is considered an essential crop used in food, and it is classified as the third most important crop of the legume family in the world, after soybean (*Glycine max L.*) and pea (*Pisum sativum L.*) [14,15,16].

Water stress reduces growth and limits the growth of faba bean shoots and roots. The reduction can be attributed to a decreased in photosynthesis, plant development, expansion, and division of cells [17,18]. Overall, water stress impacts the growth of plant organs by changing morphological and physiological characteristics plants [19]. Plants adapt to stress by varying ratio of root/shoot dry masses. [20,21]

The objective of this review at uncovering critical morphological traits linked with water stress in three crops Tomato *(Solanum lycopersicum L.)*, wheat (*Triticum aestivum L.*) then faba bean (*Vicia faba L.*). Thus, morphological characteristics of various plant species plus varieties, that have a strong association with response of plants to drought are crucial in understanding and studying water stress tolerance mechanisms.

2. Materials and Methods

2.1 Experiment methods

An experiment was conducted between June and July 2023 at research of Botany Department of Benghazi university. Three different types of crops were used: wheat, tomato then faba bean plants (Table 1).

Table 1: Plant species with common name, scientific name and family name.

Common name	Scientific name	Family
Wheat	*Triticum aestivm L.*	Poaceae
Tomato	*Solanum lycopersicum L.*	Solanaceae
Faba bean	*Vicia faba L.*	Fabaceae

The seeds in this study were sterilized in 95% ethanol of one minute, then washed with sterile water after that they rinsed with distilled water about 30 minutes. Sterilized wheat, tomato and faba bean seeds were taken it then planted in pots then placed in a well-ventilated, sunny place. Each type of plants had fifty repeated, every ten repetition of plants were written in a water stress. According to the surveys, the irrigation plan was implemented within every day, 2 days, 4 days, 6 days and 8 days.

In the first fresh parameters were measured that include: length shoots and roots (mm) by ruler, fresh weight shoots and roots (mg) by using {Mettler Toledo balance}, then placed in Oven at 70°c for 72 hours after that measured dry weights [22].

2.2 Statistical Analysis

The data were statistically analyzed by one-way test (ANOVA) for testing the difference in means using program of SPSS (version 24).

3. Result and Discussion

3.1 Response of Triticum aestivum to water stress:

Statistically analysis showed that the effect of a water stress on shoot length appear clearly at wheat plants were stressed after eight days while it had no effect on roots length as shown in (Figure 1). These results are consistent with the results of the previous study, who found the water deficit has a negative impact on the morphological characteristics of wheat such as plant high, grain weight and area of the leaf, which directly affect the yield of grain. The significant decrease in plant height maybe due to the dehydration of the protoplasm, which eventually reduces cell division, cell expansion and loss of turgor [23]. Similarly, [24,25] obtained equal results. While in fresh weight of the shoots and roots that the effect of the stress water was clear at all treatments, except when the plants were watered every day, the growth was good as the average fresh weight of the shoot was (28mg) per day compared to the fresh weight when it watered after 8 days, as the average fresh weight of the shoot was (24 mg) as shown in (Figure 2).

In (Figure 3), it is clear that the fewer the days of irrigation, the more water stress was evident to the plant in the dry weight of the shoot wheat, but as for the dry weight of the root water stress did not show any effect on it.

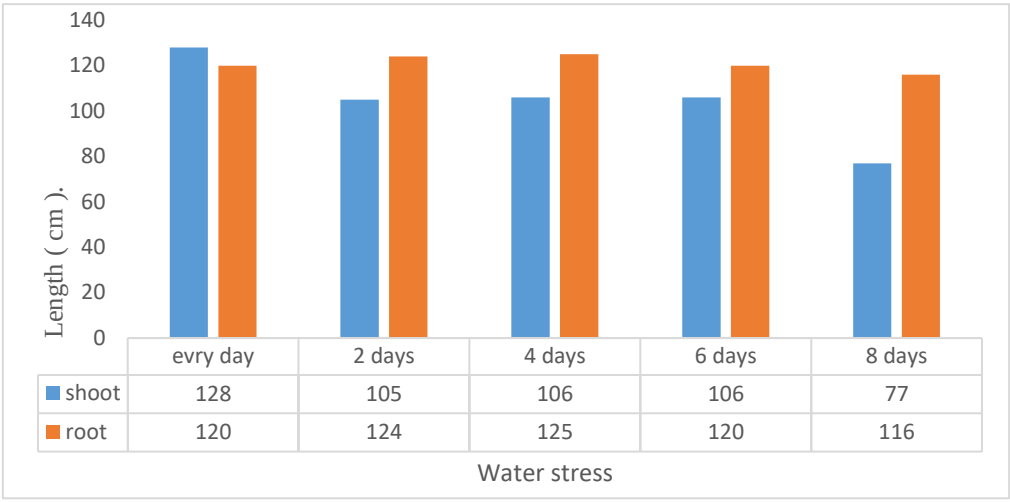

Figure 1. Effect a water stress on mean shoots and roots length of *Triticum aestivum L.*

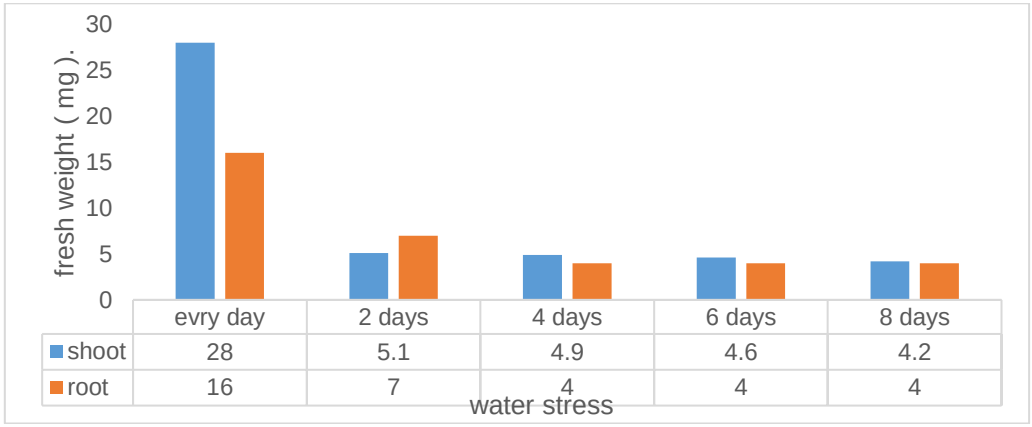

Figure 2. Effect a water stress on mean fresh weights of shoots and roots of Triticum *aestivum.*

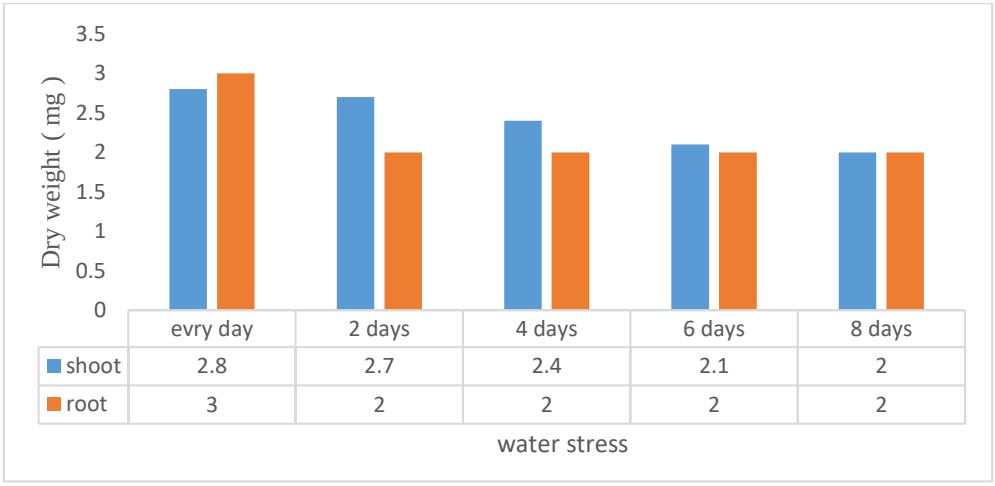

Figure 3. Effect a water stress on mean dry weight, shoots and roots of *Triticum aestivum.*

3.2 Response of Solanum lycopersicum to water stress:

Results showed that water stress on the tomato plant had an impact on the root significantly at eight days. While the effect along the shoot was very few in terms of the length as shown in (Figure 4). The results of which are

consistent with the results of [26], who found no significant differences for this trait. However, these results contrast with those of [27,28] who observed that water deficit can significantly affect the heigh of tomato plants. In (Figure 5) show the inhibition of fresh weight in shoots and roots of tomato plants. The results of our finding are in contrast with the observations of another study[29], that showed did not observe significant differences between stressed tomato plants and control tomato plants for biomass fresh weight, many other studies have reported conflictig evidence [30,31,32,33] , while the dry weight there was not any effect of roots (Figure 6) However, these results agreement with those of [34, 31, 30, 35], who observed no significant difference between stressed and control tomato plants for biomass dry weight.

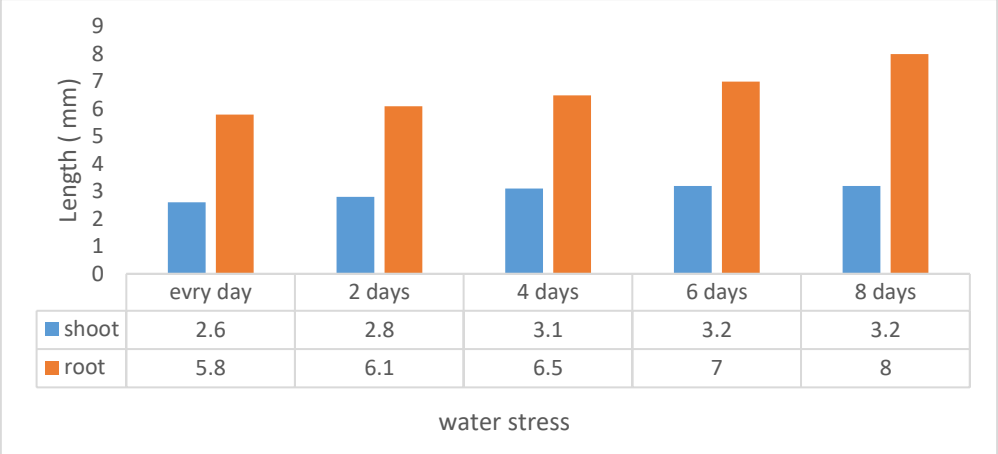

Figure 4. Effect a water stress on means length of *Solanum lycopersicum*.

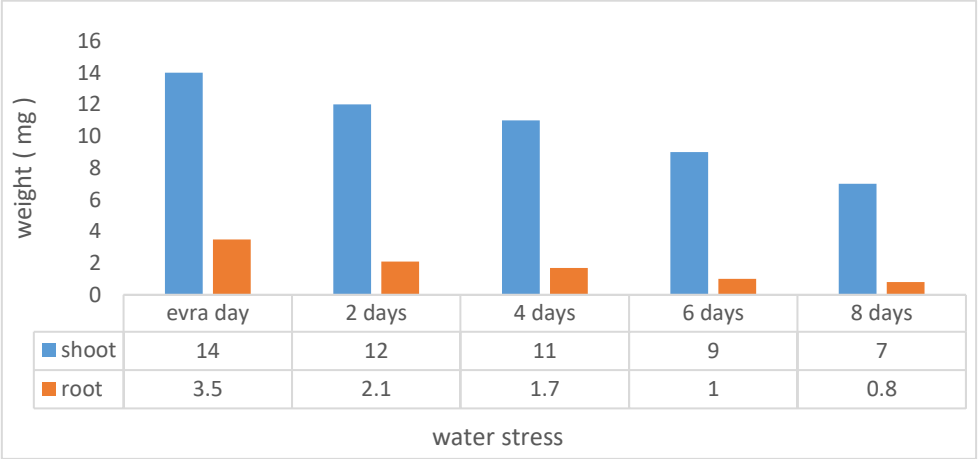

Figure 5. Effect a water stress on mean fresh weights, shoots and roots of *Solanum lycopersicum*.

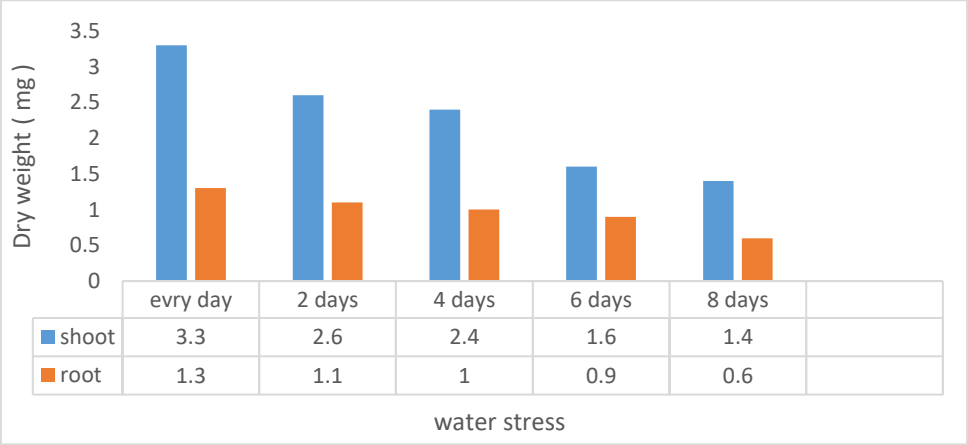

Figure 6. Effect a water stress on mean dry weights, shoots and roots of Solanum *lycopersicum*.

3.3 Response of Vicia faba to water stress:

An inhibition on length shoot of faba beans plants was clear showed occurs in (Figure 7), whenever the water stress increases on plants, where the length of faba bean shoot at daily irrigation was (357mm), while the shoot length after eight days was (233mm). This showed that the length of bean plants is affected by water stress, while the inhibition was clearly on length of roots at eight days. In fresh and dry weights, the inhibition was very clear when the faba bean plants irrigation after eight days as shown in (Figure 8, 9). Faba bean is commonly considered a drought-sensitive crop [36,37]. Most of the research includes sensitivity of faba bean plants to water deficit at different stages development. Such results agree with those reported by [38].

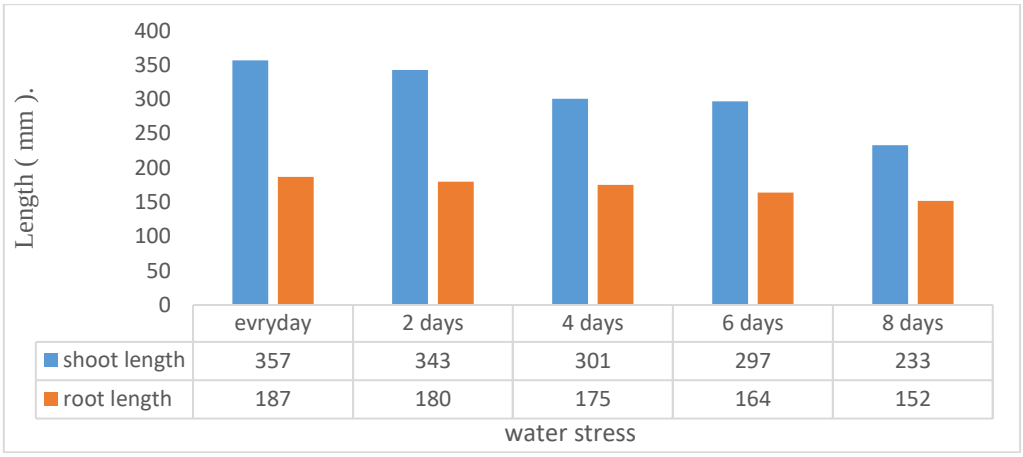

Figure 7. Effect a water stress on mean length of *Vicia faba*.

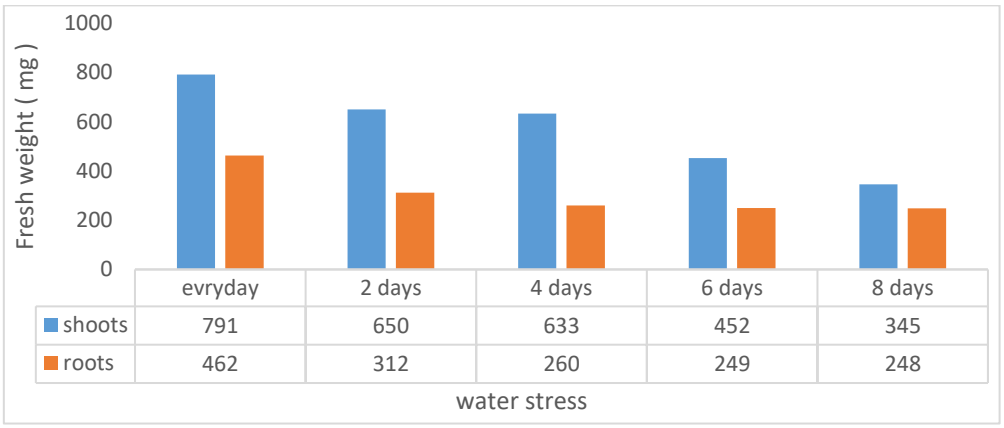

Figure 8. Effect a water stress on mean fresh weights, shoots and roots of *Vicia faba*.

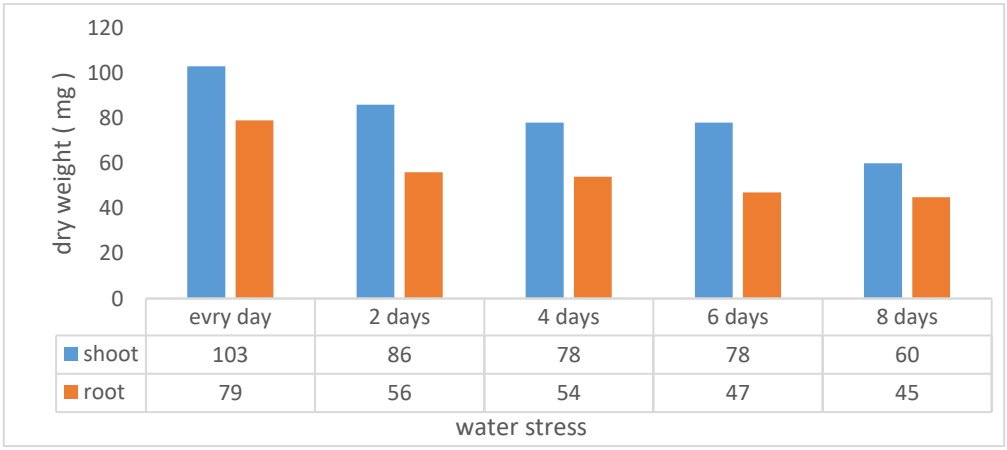

Figure 9. Effect a water stress on mean dry weights, shoots and roots of *Vicia faba*.

4. Conclusions

Several biotic and abiotic stressors continuously limit the production of agriculture. One of main abiotic stresors is water deficit, which negatively affects crop growth and productivity through reduced water potential and transpiration rate, resulting in reduced cell turgor. In result, critical properties of plant such as heigh, leaf area index, biomass, and yield are adversely affected [39]. water stress causes in the significantly decrease in different crops of production that depending on the time, stage and degree of a water stress. Plants have developed several protection mechanisms such as avoidance, tolerance and escape to protect themselves from a drought stress.

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