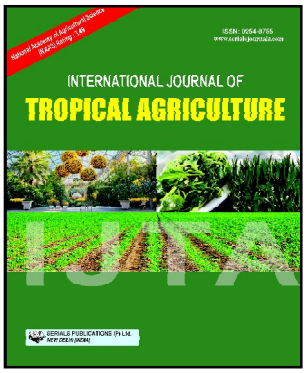

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Water Deficit Stress on Tomato and Lady's Finger

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Abstract: Water deficit in the plant disrupts many cellular and whole plant functions, having a negative impact on plant growth and reproduction. Drought stress is the major stress for many Indian states. The present study attempts to characterize the morphological and biochemical responses of Tomato (*Solanum lycopersicom L*) and Lady's finger (*Abelmoschus esculentus L*) under water stress. Morphological responses were assessed in terms of growth parameters including plant height, number of nodes, length of internodes, length of all leaves, number of flowers and fruits and all these parameters were found to be reduced under stress when compared to respective control plants. Biochemical characterization of photosynthetic pigments showed a reduction in chlorophyll and carotenoid pigments under stressed condition. Amount of total phenolics showed a considerable increase in plants under stress in both species.

Keywords: Lady's finger, Tomato, Water stress

INTRODUCTION

Modern agriculture is affected by a number of adverse environmental factors such as drought, extremes of temperature, light and salinity. In the natural environment, plants are well adapted to minimize damages which occur under these extreme conditions. The term 'stress' used by physiologists sometimes refers to the external environment factors capable of inducing a potentially injurious effect itself. Based on biological nature, stresses are two types, biotic and abiotic. The biotic stress is due to pests, insects, pathogen, weeds, etc. The abiotic stress is mainly caused due to moisture, mineral toxicity, salinity, soil factors, air pollution etc.

Drought stress is one of the most serious abiotic stresses that cause a reduction in plant growth, development, and yield in many parts of the world [1, 2, 3]. It is one of the greatest environmental factors which reduces yield in the arid and semi-arid tropics. From agricultural point of view, drought is

defined as the inadequacy of water availability, including precipitation and soil moisture storage capacity, in quantity and distribution during the life cycle of a crop plant that restricts the expression of full genetic potential of the plant [4].

Water availability and quality affect the growth and physiological processes of all plants since water is the primary component of actively growing plants ranging from 70-90% of plant fresh mass [5]. Due to its predominant role in plant nutrient transport, chemical and enzymatic reactions, cell expansion, and transpiration, water stresses result in anatomical and morphological alterations as well as changes in physiological and biochemical processes affecting functions of the plants [6, 7]. Drought stress can adversely affect root and shoot growth resulting in reduced leaf surface area [8]. Exposure to environmental stresses such as drought stress, heat stress, cold stress, salt stress and plant stress often leads to the production of reactive oxygen species [9], and other toxic compounds that diminish a plant's performance [10].

Frequent drought is the major consequence of global climate change. Physiological, biochemical, molecular changes occur in plant during stress condition. Low water availability reduces metabolic process such as water and mineral absorption, rate of photosynthesis, dry matter production and yield. Physiological and molecular changes make plants resistant to drought stress.Being very complex, the drought tolerance mechanism involves a number of physiological and biochemical processes at cell, tissue, organ and whole-plant levels, when activated at different stages of plant development. Lady's finger (*Abelmoschus esculentus L.*) is a vegetable crop which can be predominantly grown in tropics and subtropics. The species is a perennial one; having fibrous fruits or pods containing round white seeds. The products of the plants are mucilaginous. They have high amount of nutritive value and contains carbohydrate, sugars, fat, protein, vitamins, etc. Tomato (*Solanum lycopersicum L.*) is an important Solanaceous vegetable crops of widespread and popularity. It is a rich source of health building substances particularly vitamins and minerals. Tomato and lady's finger are sensitive to water deficit condition during each stage of life cycle. Hence the present study attempts to characterize the morphological and biochemical responses of these plants under water stress.

MATERIALS AND METHODS

The seeds of tomato and Lady's finger were purchased from the sales counter of College of Agriculture, Vellayani, Thiruvananthapuram. Four seeds were planted within each bag and a maximum of 50 plants were raised from both plants.After a growth period of one month the plants were kept in water stressed condition by withholding water along with one set maintained for each as respective controls.

Morphological Characterization

Morphological characterization of treated and control plants were made immediately after the treatment period. Plant height, number of nodes, length of internodes, length of leaves, number of flowers and number of fruits were measured as an indicator of plant growth and development. Plant height was measured in centimeters from base of petiole to leaf tip.

Biochemical characterization

Selected biochemical parameters were used as a measure of drought stress responses in both tomato and Lady's finger. Amount of chlorophyll, carotenoids and total phenolics were estimated from fresh leaf tissues harvested from the seedlings after the period of stress treatment. Chlorophyll pigments were estimated spectrophotometrically using the method of Arnon (1949)[11]. The total phenolic contents of leaf extract were determined according to the method described by Malik and Singh (1980) [13].

RESULTS AND DISCUSSION

Effect of drought stress on plant growth and development

Effect of water deficit stress on plant growth and development were measured in terms of plant height, number of leaves, length of leaves and internodes, number of flowers and number of fruits. In tomato, plant height was 36cm in the control plants, while treated plants showed a reduction in height. Similarly, in Lady's finger also, treated plants showed a reduction in plant height when compared to the controls. Internodal length was also found to be reduced in treated plants of Tomato and Lady's finger as the former showed a reduction from 3.8cm (in control) to 3.5cm (in stressed) and the later showed a reduction from 3.5cm (in control) to 3cm (in stressed). Leaf length also showed a similar trend. In tomato length of leaf reduced from 3.6cm (in control) to 3.2cm (in stressed) and in Lady's finger from 8.5cm (in control) to 8cm (in stressed) (Table 1). In water deficit plants of tomato and lady's finger leaf colour changed to pale green and yellowish green and later the leaves shed off. This shows chlorosis in the leaves of test plants under water stress.

BIOCHEMICAL CHARACTERIZATION

Estimation of Photosynthetic Pigments

Biochemical estimation of photosynthetic pigments showed significant reduction in chlrophyll a,chlrophyll b, total chlorophyll and carotenoid pigments under drought stress. In both Tomato and Lady's finger plants amount of chlorophyll and carotenoids reduced considerably under stress condition. In tomato, total chlorophyll was reduced from 0.138mg/g tissue (in control) to 0.0305mg/g tissue (in treated) while carotenoids showed a reduction from 0.936 mg/g tissue to 0.352 mg/g tissue (Table 2).

Estimation of total phenolics

Amount of total phenolics showed a considerable increase in plants under stress in both species. In tomato, total phenolics increased from 0.48253 mg/g leaf tissue (in control) to 0.6253 mg/g leaf tissue (in stressed). Similarly, in Lady's finger also an increase from 0.3775 mg/g leaf tissue (in control) to 0.4532 mg/g leaf tissue (in stressed) was observed. Present study observed retardation of plant growth and development in both tomato and lady's finger species

Table 1
Evaluation of morphological parameters in Tomato and Lady's finger under drought stress

Plants ⟹	*Tomato*		*Lady's finger*	
Parameters ⇩	*Control*	*Stressed*	*Control*	*Stressed*
Plant height (cm)	36	34	27	24
Lengthofinternode(cm)	3.8	3.5	3.5	3.0
Number of leaves	28	22	6.0	4.0
Length of leaves	3.6	3.2	8.5	8.0
Number of flowers	9.0	5.0	1	1
Number of fruits	9.0	3.0	1	1

Table 2
Estimation of photosynthetic pigments and total phenolics in Tomato and Lady's finger under drought stress

Plants ⟹	*Tomato*		*Lady's finger*	
Parameter ⇩	*Control*	*Stressed*	*Control*	*Stressed*
Amount of chl_a (mg/g leaf tissue)	0.106	0.045	0.0422	0.0374
Amount of chl_b (mg/g leaf tissue)	0.196	0.091	0.085	0.066
Amount of total chl (mg/g leaf tissue)	0.305	0.138	0.128	0.104
Amount of Carotenoids (mg/g leaf tissue)	0.936	0.352	0.21	0.137
Amount of total phenolics (mg/g leaf tissue)	0.4821	0.6253	0.3775	0.4532

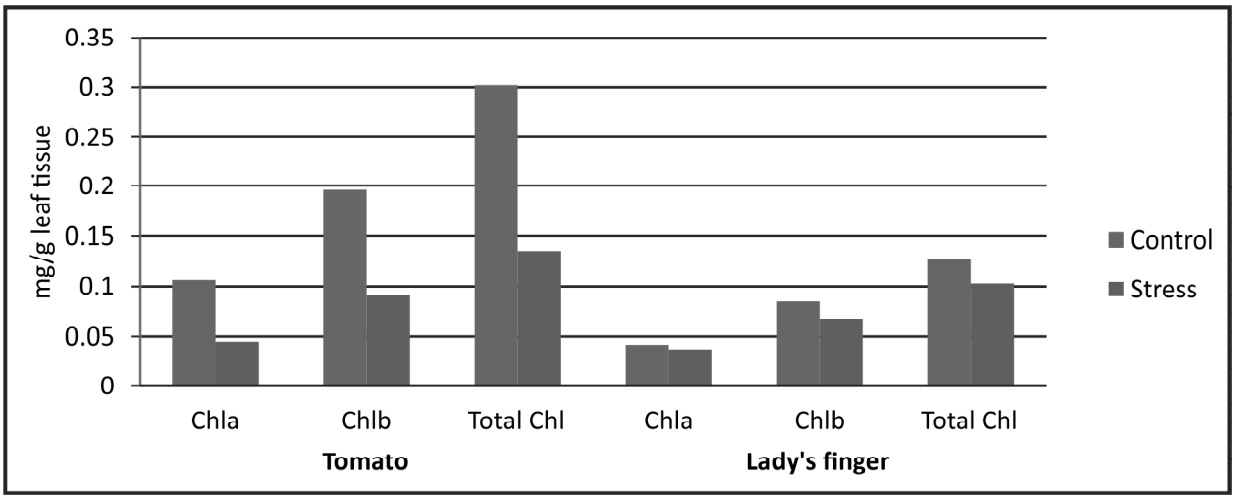

Figure 1: Reduction in photosynthetic pigments in tomato and lady's finger under water deficit stress

under water deficit stress along with an increase in total phenolics and decrease in photosynthetic pigments. It can be concluded that the plant responds to water deficit stress by minimizing the plant size, leaf size etc. The plant tolerance is orchestrated by the increased production of phenolics which act as a compatible solute for osmotic adjustment. Further works are needed for the better understanding of water stress deficit mechanism of these plants.

CONCLUSIONS

Present investigation was carried out to characterize the drought stress responses in Tomato (*Solanum lycopersicum L.)* and Lady's finger *(Abelmoschus esculentus L.)* at morphological and biochemical level. Drought stress affected the plant growth and development adversely in both Tomato and Lady's finger. Plant growth and development were measured in terms of plant height, number of nodes, length of leaves, intermodal length, number of flowers and number of fruits. All the parameters showed a reduction under water stress when compared to the respective controls. Present study observed retardation of plant growth and development in both Tomato and Lady's finger species under drought stress along with an increase in total phenolics and decrease in photosynthetic pigments. The plant tolerance is orchestrated by the increased production of secondary metabolites, which act as compatible solutes for osmotic adjustment. Further works are needed for the better understanding of drought tolerance mechanism of both Tomato and Lady's finger.

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