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EFFECT OF DROUGHT STRESS IN PHASEOLUS VULGARIS AND ABELMOSCHUS ESCULENTUS

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ABSTRACT

Plants are often subjected to various abiotic stress factors that adversely affect their growth and yield. Stress may result in abnormal metabolism and reduce growth. Monitoring the morphological, physiological and biochemical changes will give an insight into the extent of damage caused by drought stress. In the present study the effect of drought was studied on *Phaseolus vulgaris* (common beans) and *Abelmoschus esculentus* (lady's finger). The morphological parameters like shoot and root length and the activity of peroxidase were also analyzed.

Keywords: Drought stress, Morphological, physiological, biochemical, peroxidase, abiotic stress

INTRODUCTION

Drought is the most important abiotic factor limiting growth and development. Drought stress, leads to reduced seed germination as adequate moisture content is required (Abbate *et al*., 2004; Abdul *et al*., 2007). The root architecture is modified in severely drought stressed plants than the plants that are affected by mild water deficit. Leaf area is significantly reduced in many plants. Leaf area is an important parameter for photosynthesis and yield (Amandeep and Rashpal, 2020; Monyo and Whittington, 1973). The increase in leaf area is depended on the turgor pressure, canopy temperature and availability of photo-assimilates (Amandeep and Rashpal, 2020; Bilal *et al*., 2015; Khakwani *et al*., 2013)

Leaves of drought stressed plants tend to roll due to the loss of potential pressure when there is water loss from the upper epidermis of the leaf (Abd-El-Haleen *et al*., 2009). Leaf rolling helps to reduce the temperature, area of incident radiation and thereby transpiration rate. There is a decline in plant height due to reduced cell expansion, improper mitosis and increase in leaf abscission (Kulkarni *et al*., 2008; Eszter and Lajos, 2019). Increased leaf senescence and reduced cell enlargement are the two primary reasons for decreased plant height.

The defense mechanisms adopted by plants to protect from drought stress include reduced water loss by an increase in diffusive resistance, water uptake and with extensive deep root systems, smaller, succulent leaves to decrease transpiration loss (Amandeep and Rashpal, 2020). Chlorophyll pigments help to capture light for photosynthesis. Carotenoids content is also depleted during stress. The protein content in the plant leaves decreases during water deficiency due to the decreased synthesis, significantly in C_3 than in C_4 plants (Siddique *et al*., 2001). Water stress alters gene expression leading to reduced synthesis of new proteins and mRNAs (Abd-El-Haleen *et al.*, 2009). Drought stress resulted in impaired photosynthetic system (Amandeep and Rashpal, 2020). The rate of respiration in leaves, shoots, roots, flower apices and in whole plant is reduced due to water deficit. Stomatal conductance which is associated with the soil moisture content is also affected. Severe drought stress leads to stomatal closure and hence reduced net photosynthesis (Sullivan, 1971). A noted feature of drought resistant plants is its cell membrane stability and integrity. Osmoregulation by the accumulation of osmolytes is another step in the mitigation towards drought stress (Amandeep and Rashpal, 2020).

Malondialdehyde is responsible for cell membrane damage (Mafakheri *et al*., 2010). It is more pronounced in certain properties of cell membrane. These changes result in cell death. Moreover, water stress affects nutrition uptake in plants by disrupting ion homeostasis (Sullivan, 1971). Calcium helps in the stability of cell membrane and potassium helps in osmotic adjustment and stomatal movement. The accumulation of abscisic acid in drought stress is a sign of protection against dehydration (Sullivan, 1971). Transgenic plants are developed for stress resistance based on the manipulation of genes that are involved in stress response in plants. The genetic engineering strategies depend on the manipulation of genes involved in plant stress physiological pathways (Abd-El-Haleen *et al.*, 2009). The study describes the effect of drought stress in *Phaseolus vulgaris* (common beans) and *Abelmoschus esculentus* (lady’s finger) by investigating their morphological and biochemical parameters.

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MATERIALS AND METHODS

Plant material

The seeds of *P. vulgaris* and *A. esculentus* were procured from Chennai and were germinated in a raised bed nursery. After germination they were transplanted in the field.

Morphological parameters

The morphological parameters like shoot and root length, shoot and root diameter, number of leaves and leaf length were measured.

Enzyme activity

The activity of peroxidase was analysed using the standard procedure using pyrogallol as substrate and measured the absorbance at 420 nm.

RESULTS AND DISCUSSIONS

The effect of drought stress was studied on two plants *P. vulgaris* and *A. esculentus*. The results of the morphological parameters and the enzyme analysis studied are shown below (Table 1 and Table 2).In this study, common bean and lady's finger genotypes were subjected to three watering treatments for 14 days. A reduction in the fresh weight of common bean and lady's finger seedlings under drought conditions showed an inhibition of growth. Water deficiency reduced fresh weight of bean plants compared to the control.

Table 1 Effect of drought stress on the morphological parameters of *Abelmoschus esculentus*

PARAMETERS	CONTROL	DROUGHT
Average plant length(cm)	96.2	66
Average stem diameter(mm)	14.04	8.04
Average root length(cm)	48.2	32
Average root thickness(cm)	5	3
Average no of leaves	30	15
Average leaf length(cm)	10	6

The fresh weight decreased by 40 and 60% under moderate stress. However, the decrease fresh weight reached 60% in Beans and 84.6% in lady's finger under conditions compared with control groups. The shoot length of beans drought plant to control plant of beans was dramatically decreased. The shoot length of the beans and lady's finger genotype under week 2 and week 4 drought conditions decreased by 14.04cm - 8.04cm and 12 cm - 5cm, respectively.

Table 2 Effect of drought stress on the morphological parameters of *Phaseolus vulgaris*

PARAMETERS	CONTROL	DROUGHT
Average plant length(cm)	83	30
Average stem diameter(mm)	12	5
Average root length(cm)	28	15
Average root thickness(cm)	4	2.5
Average no of leaves	30	15
Average leaf length(cm)	7	4

However, that of the sensitive beans and lady's finger genotype under these stress conditions decreased by 47.7 % and 62.4 %, respectively. The decrease may have been due to decline in net assimilation, brought about by decreased leaf water potential. The effect of water stress on yield may be accentuated, since the rate of decline in rate of photosynthesis maybe higher than that of respiration rate under water stress (Emam et al., 2010).

The performance of *A. esculentus* plants after the second week drought treatment is shown in Fig 1. Control plants are healthier than the drought treated plants. The results are consistent with the previous studies. In addition, the leaf number is significantly decreased in Beans compared to the control in response and drought treatment.

A **B**

Fig 1 Growth of *Abelmoschus esculentus* (Week 2) A- Control; B- Drought treated

The growth and development of *A. esculentus* plants after the fourth week drought treatment is shown in Fig 2. The control plants are performing better than the drought treated plants.

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A **B**

Fig 2 Growth of *Abelmoschus esculentus* (Week 4) A- Control; B- Drought treated

The growth and development of *P.vulgaris* plants after the second week drought treatment is shown in Fig 3. The control plants are performing better than the drought treated plants. With drought stress leaf area decreased by 30cm to 50cm in Beans and lay's finger, however, this decrease was determined to have been by 83 cm to 30cm in Beans and lady's finger under week 2 and week 4 treatments compared with the control groups, respectively.

A **B**

Fig 3 Growth of *Phaseolus vulgaris* (Week 2) A- Control; B- Drought treated

The growth and development of *P.vulgaris* plants after the fourth week drought treatment is shown in Fig 4. The control plants are performing better than the drought treated plants.

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A **B**

Fig 4 Growth of *P.vulgaris* (Week 4) A- Control; B- Drought treated

Peroxidase accumulation is an important physiological index for plant response to drought stress, as well as to other types of stress (Kaymakanova and Stoeva, 2008). The peroxidase concentration in all of the bean and lady's finger genotypes increased after water stress (Table 3 and 4). However, under the same conditions, peroxidase concentration of the Beans increased to a greater extent than lady's finger genotype.

Table3 Peroxidase activity of control plants of *Phaseolus vulgaris* and *Abelmoschus esculentus* expressed as micrograms of pyrogallol

Control	***Phaseolus vulgaris***	***Abelmoschus esculentus***
Week 2	0.001	0.001
Week 3	0.002	0.001
Week 4	0.002	0.0015

Table 4 Peroxidase activity of drought treated *Phaseolus vulgaris* and *Abelmoschus esculentus* expressed as micrograms of pyrogallol

Drought stressed	***Phaseolus vulgaris***	***Abelmoschus esculentus***
Week 2	0.001	0.0005
Week 3	0.0015	0.001
Week 4	0.003	0.0015

Drought increased peroxidase content markedly in different drought sensitive and tolerant genotypes. In this study, the peroxide content increased due to drought stress. This

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increase was by 20-93 % in the 2 plants (Beans and lady's finger), however this changed to 20- 30% in the sensitive genotype beans and lady's finger compared to the control plants.

From the observations it was found that *P. vulgaris* and *A. esculentus* genotypes was able to increase their ability to up-regulate antioxidative systems and make adjustments in osmotic regulation in response to drought stress. Our results showed that drought stress caused damage in the bean and lay's finger genotypes.

CONCLUSION

Morphological and biochemical analysis were done using enzyme peroxidase. In this study two plants were used one is Beans. Results revealed that lady's finger can tolerate drought whereas beans cannot tolerate and leads to death of plants. Drought stress affects their growth and development. In future, other parameters like physiological and biochemical responses were studied to get better growth of plant.

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