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Effect of Drought on The Morphological and Mineral Composition of *Abelmoschus esculentus*

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Abstract: The present study was carried out, in order to determine the effect of stress (drought) on the morphological and mineral composition of *Abelmoschus esculentus* (L.) Moench. Two plants, one each under control and stress condition were selected at the time of maturity. The recorded data shows that drought has effected plant height, diameter of stem, diameter of tap root, leaf area, number of leaves per plant, number of fruit per plant and average number of seeds per fruit. The mineral contents shows that stress has effected %DW concentration of Na, Mg, Si, P, S, Cl, K, Ca and Al variably. Under stress condition, fruit has Na, Mg, Si and K, bark has Na, Mg, Si, Cl and K, leaves have Mg, SI, P and K, stem has Na and root has Si, P, Cl, Ca and Al in high percent (%) dry weight (DW) concentration compared to control condition. Ca was detected in less %DW concentration in fruit, bark, leaves and root than the control.

Key words: *Abelmoschus esculentus* · Drought · Morphological · Mineral Composition

INDRODUCTION

All human beings require a number of complex organic compounds as added caloric requirements to meet the need for their muscular activities. Carbohydrates, fats and proteins form the major portion of the diet, while minerals and vitamins form comparatively a smaller part. Plant materials form a major portion of the diet; their nutritive value is important [1].

Abelmoschus esculentus (L.) Moench has the synonym *Hibiscus esculentus* (L.), *Abelmoschus* suggesting the musky odor produced by the seeds. This plant is commonly known as okra, gumbo or lady's finger and used as vegetable [2].

From Arabia, the plant spread around the shores of the Mediterranean Sea and eastward. The lack of a word for okra in the ancient languages of India suggests that it arrived there in the Common Era. *Abelmoschus esculentus* is cultivated throughout the tropical and warm temperate regions of the world for its fibrous fruits or pods containing round, white seeds. The fruits are harvested when immature and eaten as a vegetable [3].

A. esculentus ranges in height from 0.5 to 4 meters, with a main, semi-woody stem, a taproot and generally five-lobed or five-parted leaves. The conspicuous flower is hermaphroditic, having free petals in yellow colors with a deep red or purple center. Different varieties in the fruit range in color from white, green, or purple, depending on the green and red pigmentation. The fruit pod can be as long as 70 cm and straight or curved with four to nine sutures. Small spines are found on the mature fruit that often irritate the skin.The young leaves also are edible and the seeds are used for oil and feed. The consumption of the fresh fruit is the main use of *A. esculentus* [2]. Though not as commonly consumed, the leaves and seeds contain higher nutritional and protein values than the fruit. Considering the adaptability and vigor of this plant, it is not well known for its economic and ecological value. Many wild varieties still exist, ensuring its genetic diversity. Select breeding for varieties with higher pest and disease resistance would increase its importance in the tropics [3]. Nutritional value per 100 g of *A. esculentus* shows that it contains carbohydrates (7.6g), Dietary fibers (3.2g), Fat (0.1g) Protein (2g), Folate (VitamineB9) 87.8µg, Vitamin C 21mg, calcium (75 mg) and Magnesium (57 mg) (NRC, 2006). From medicinal point of viev *A. esculentus is used to treat eye diseases superficially conjuntivities* [3]. Besides being a foodstuff, it has been used for treating ailments such as ulcers, inflammation, conjunctivitis and hemorrhoids [2]. Many of the local

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vegetable materials are under-exploited because of inadequate scientific knowledge of their nutritional potentials. Though several works reporting compositional evaluation and functional properties of various types of edible wild plants in use in the developing countries abound in literature, much still need to be done. Many workers conducted similar compositional evaluation and functional properties of various types of edible plant in different developingcountries of the world [4-10]. In continuation of our research work on Pakistani medicinal plants [11-18], this work is aimed to document the effect of drought on the morphological and elemental composition of various parts of *Abelmoschus esculentus*, which in turn can be useful in determining the nutritional value of the said vegetable plant.

MATERIALS AND METHODS

Two plant samples of *Abelmoschus esculentus*were obtained from two farmlands, one was being provided with enough water while the other was under water deficit conditions. The collected samples were rinsed with fresh running water to eliminate dust, dirt and possible parasites. Before drying, various morphological characteristics like plant length, average stemdiameter, average tap root diameter, average leaf areanumber of leaves per plant, number of fruit per plant and average number of seeds per fruitof both sampleswere calculated. The samples were then dried in shade under temperature of 25-30°C. Parameters like root, stem, bark, leaves and fruit were selected from samples, ground into fine powder, which were then used for elemental analysis with the help of energy depressive X-Ray spectrometer (EDX), model (Inca-200).

RESULTS AND DISCUSSION

Table 1 shows the recorded data of *Abelmoschus esculentus* on plant height (cm), average diameter of stem (cm), average diameter of tap root (cm), average leaf area, number of leaves per plant, number of fruit per plant and average number of seeds per fruit. Stress (drought) reducesplant height, diameter of stem, diameter of tap root, leaf area, number of leaves per plant, number of fruit per plant and average number of seeds per fruit. Effect of drought stress on mineral composition in % concentration DW for root, stem, leaves and fruit of *Abelmoschus esculentus* are given in Table 2. Na was detected in higher % concentration in fruit (0.51%DW) followed by bark (0.20%DW) and stem (0.15%DW) under stress condition while it is not detected in any part under control condition. Na and K take part in ionic balance of the human body and maintain tissue excitability. Because of the solubility of salts, Na plays an importantrole in the transport of metabolites. The Na/K ratio in the body is of great concern for preventionof high blood pressure. Na/K ratio less than one isrecommended [19]. Higher concentration of Mg was found to be present in fruit (0.58%DW), bark (0.46%DW) and leaves (0.68%DW) under stress (drought) condition as compared to the control. Lesser amount was detected in root (0.29%DW) and stem (0.13%DW) than the control root and stem. In humans, Mg is required in the plasma and extracellular fluid, where it helps maintain osmotic equilibrium. It is requiredin many enzyme-catalysed reactions, especially those in. Lack of Mg is associated with abnormal irritability of muscle and convulsionsand excess Mg with depression of the central nervoussystem [21]. This is a component of chlorophyll [20]. Lack of Mg is associated with abnormal irritability of muscle and convulsions and excess Mg with depression of the central nervoussystem [1]. Si was detected in higher concentration in leaves (1.14%DW) followed by root (1.04%DW), fruit (0.37%DW) and bark (0.18%DW) under stress condition than leaves, root, fruit and bark of control condition. Si is believed to hook fibrous body tissues, collagen and elastin tightly together. It may be considered to play some role in bone structure [22, 23]. Drought Stressreduces the amount of P than the control in fruit (0.33%DW) and bark (0.37%DW) while its amount increases in leaves (0.74%DW), root (0.59%DW), fruit (0.51%DW) and bark (0.45%DW) as compared to control situation. Calcium and phosphorus are associated with each other for growth and maintenance of bones, teeth andmuscles [24]. Sulphur DW% was found alittle higher in stem (0.25%DW) and fruit (0.26%DW) in the stress condition whileits amount detected to be decreased in bark (0.25%DW), stem (0.37%DW) and root (0.18%DW) than the control. S Plays a role in most body functions. It is Universally required for the enzymes that speed body chemicals reactions. No symptoms of toxicity have been documented. High levels can interfere with selenium availability [22]. Chlorine was found in lesser concentration in stressed fruit (0.69%DW) and leaves (0.26%DW). Under stress condition its amount detected in higher concentration in the leaves (0.78%DW), root (0.49%DW) and stem (0.26%DW). Chlorine is necessary for maintaining osmosis and ionic balance in plant [23]. Trace levels seem

Table 1: Comparison of morphological features of *Abelmoschus esculentus* under control and Stress (drought) condition

S.no	Parameter	Control	Stress (Drought)
1	Plant length	259 cm	96 cm
2	Average Diameter of stem	0.982 cm	0..413 cm
3	Average Diameter of tap root	0.638 cm	0.214 cm
4	Average leaf area	274.22 cm^2	82.56 cm^2
5	Numbers of leaves per plant	27	14
6	Number of fruits per plant	15	06
7	Average number of seeds per fruit	56	38

Table 2: Comparison of various elements under control and Drought strss condition in *Abelmoschus esculentus* (L.) Moench

	Control					Stress (Drought)				
Elements (weight %)	Root	Stem	Leaves	Bark	Fruit	Root	Stem	Leaves	Bark	Fruit
Sodium (Na)	NA	NA	NA	NA	NA	NA	0.15	NA	0.20	0.51
Magnesium (Mg)	0.67	0.30	0.46	0.42	0.41	0.29	0.13	0.68	0.46	0.58
Silicon (Si)	0.33	0.20	0.88	NA	0.33	1.04	0.13	1.14	0.18	0.37
Phosphorus (P)	0.21	0.20	0.33	0.41	0.49	0.59	0.45	0.74	0.37	0.33
Sulphur (S)	0.25	0.19	0.46	0.45	0.23	0.18	0.37	0.44	0.25	0.26
Chlorine (Cl)	0.36	0.39	0.41	0.49	0.85	0.49	0.26	0.78	0.71	0.69
Potassium (K)	1.68	1.55	1.23	2.99	1.74	1.62	1.48	2.34	3.53	2.85
Calcium (Ca)	0.18	0.79	3.79	3.41	1.35	1.30	0.68	2.76	1.87	0.77
Aluminum (Al)	NA	NA	NA	NA	NA	0.65	NA	NA	NA	NA

Key word: NA=Not detected

beneficial in root rot control in wheat and barley. Potash fertilizer is Kcl. Essential for body fluid regulation (Evans and Solburg, 1998). Potassium, under stressed condition was in the tune of bark (3.53%DW), fruit (2.85%DW), leaves (2.34%DW), root (1.62%DW) and stem (1.48%DW). The values for bark, fruit and leaves were higher than the control condition. K is of importance asa diuretic [1]. K is needed for protein synthesis and operation of stomata [23]. Involved in nerve impulses and muscle contraction, including the heart muscle [22].

Under drought condition the DW % concentration of Ca was found lower in stem (0.68), fruit (0.77), root (1.30), bark (1.87) and leaves (2.76) than the control condition. Ca constitutes a largeproportion of the bone, human blood and extracellularfluid; it is necessary for the normal functioning of cardiacmuscles, blood coagulation and milk clotting and the regulation of cell permeability. It also plays an importantpart in nerve-impulse transmission and in the mechanismof neuromuscular system [4]. Al was detected only in the root (0.65%DW) under stressed condition.

CONCLUSION

It is concluded from the results achieved that stress (drought) has effected the morphological features of *Abelmoschus esculentus.* The mineral composition shows variable results for Na, Mg, Si, P, S, Cl, K, Ca and Al. It is necessary to consider other aspects, such as biological evaluations of nutrient content of the plant in order to determine the bioavailability of the nutrients under stress condition.

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