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Analysis of minerals under different water stress levels in *Andrographis paniculata* (Burm.f.) Wall. Ex Nees

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ABSTRACT

Medicinal plants have diverse use in the society from medicine to cosmetics to herbal foods with vast potential for their curative medicinal properties. Minerals are essential nutrient for plant metabolism and over all growth of the plants. The overall growth of the plant depends upon the availability of the water. The aim of this study was to determine the mineral content under different water stress levels in *Andrographis paniculata.* The homogenized leaf samples of controlled plants(Daily watered), treated T2 plants(watering 2nd day), T4 plants(watering on every 4th day), T7 plants(watering on every 7th day) were subjected to overnight $HN0_3$ digestion and analyzed for the presence of Copper, Chromium, Iron, Aluminum, Zinc, Manganese and Phosphorous. With increase in water stress, element content deceased with varied fractions. The T2 treated plants, irrigated every second day, could withstand the water stress conditions without affecting minimum mineral content in *Andrographis paniculata* plants and T2 treatment has been chosen the best option to withstand water stress conditions.

Keywords: *Andrographis paniculata,* water stress, minerals.

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INTRODUCTION

Plants possessing medicinal properties play an important role in Ayurveda, Siddha, Unani and Homeopathy treatments. Herbal treatments are the most popular form of traditional medicine and applied to the treatment of chronic and acute conditions and various ailments and problems such as cardiovascular disease, prostate problems, depression, inflammation, and to boost the immune system. *Andrographis paniculata* (Burm. f.) Wall. ex Nees is an annual herbaceous plant which belongs to Acanthaceae family. It is also known as Kalmegh and used in traditional Siddha and Ayurvedic systems of medicine in India. Andrographolide is the major constituent extracted from the leaves of the plant which is a bicyclic diterpenoid lactone. This bitter principle was isolated in pure form by Gorter[9] and in traditional medicine, as *Andrographis paniculata* is widely used to free body heat, dispel toxins from the body; prevent common cold, coughs, upper respiratory tract infections including sinusitis and fever and as an antidote against poisons of snakes and insects. It also possess antibacterial, antiviral, anti-inflammatory, anti HIV(Human immunodeficiency virus), anticancer properties, cures liver disorders, leprosy, diabetic, throat infections, believed to be effective in the treatment of gall bladder conditions such as viral hepatitis, drug induced liver damage. The mineral elements, when represent in the form of ions or as constituents or organic molecules, perform several important functions in plants in different biochemical pathways.

Minerals are differentiated into essential minor and trace elements depending upon the specific role in plant metabolism[12]. They have a specific role in plant metabolism as few are also toxic in nature, some act as activators or inhibitors in one or more enzymatic systems. The mineral elements present in plants may be influenced by numerous agronomic and environmental factors such as heat, cold temperatures, water and osmotic stress. Among them, water stress is one of the most serious environmental factors undermining plant growth and development[6]. It is induced either by the low soil water content or by the increasing concentrations of soluble salts in the root zone which restricts the ability of plants to get enough water[11]. In turn affects lower yields and can cause crop failure[4] and is considered as one of the most important environmental stresses affecting agricultural productivity worldwide[3] by controlling the physiological process that determine the quality and quantity of growth[14]. Plant water stresses,

usually caused by drought have major impacts on plant growth and development. Among the important medicinal plants, *Andrographis paniculata* is used in several traditional and modern methods of medicine and chosen for the study.

Viewing its importance, an effort has been made keeping in view the growing water scarcity, an experiment is carried out under different water stress levels in *Andrographis paniculata* to analyze few minerals which helps in growth and metabolism of the plant.

MATERIALS AND METHODS

A pot experiment was designed for *Andrographis paniculata* under controlled water stress conditions in glass house maintained in the botanical garden, Osmania University, Hyderabad. Seeds were sterilized with 0.1%(w/v) Sodium hypochloride solution for 5min thoroughly rinsed with distilled water, germinated in plastic pots containing mixture of soil and sand(2:1) allowed to germinate. The experiment was laid out is completely randomized design with four treatment at different water stress levels i.e., Control (Daily watered), T2 (Watered on every 2nd day), T4 (Watered on every 4th day), T7 (Watered on every 7th day) each with three replicates was carried out. When the seedlings attained 15cm length (19day old plants), the plants were subjected to a progressive water stress by withholding water. The growth parameters such as plant height, shoot length, root length, number of leaves, leaf area, fresh and dry weight were recorded every 30days, all the morphological and physiological parameters were measured. Leaves were oven dried(60°C, 48h) and the mass of each leaf was weighed with an electric balance(to 0.001 g.).

Elements present in the water stressed leaves were quantitatively investigated by flame atomic absorption spectrometry. In each of the leaf extract of *Andrographis paniculata*, Fe, Zn, Mn, P, Co, Al, and Cr, contents were measured under the optimum operating conditions with an air-acetylene flame. The mineral analysis carried on 8th month old plants through acid dilution test.

RESULTS

Metal analysis performed in *Andrographis paniculata* which were subjected to different water stress levels revealed moderate variations when compared to control. This indicate that *Andrographis* can tolerate water stress levels without undergoing much changes in the normal growth metabolism up-to extreme drought conditions. Along with the mineral analysis, plant growth parameters were considered to check the growth levels such as Plant height; Root length, Leaf number and fresh weight of the plant were taken to check the water stress affect compared with control. All the parameters decreased with the increase water stress levels but root length has increased with increased water stress level with mean value of 29.62±0.55 (T7 treatment) (Table 1). Mineral analyzed with acid digestion test showed variation with the increasing water stress levels.

Copper-Plants subjected to different water stress levels (Table 2) showed medium variations in copper content when compared with the control. The maximum copper content was recorded in T2 treatment with an average of 0.38±0.01 mg/100gm the minimum copper content recorded in T7 treatment with an average of 0.25±0.01mg/100gm.

Chromium: Water is considered as a important factor which influences seed germination which in turn is affected by Chromium content. At different water stress levels maximum chromium content was observed in T2 treatment with average of 0.21±0.01mg/100gm and minimum in T7 treatment with average of 0.18±0.01 mg/100gm when compared with that of the control 0.28±0.01mg/100gm.

Iron: Iron is the main important element in chlorophyll synthesis, and also is the structural component of several compounds such as, cytochrome, ferridoxin, cytochromes, peroxidase, catalase and nitrite reductase. In T7 treated plants an average of 1.95±0.01mg/100gm is observed when compared with an average control reading of 3.58±0.01 mg/100gm.

Aluminum: Stimulates growth at low concentrations and considered as trace element. The maximum aluminum content was recorded in T2 treatments with an average of 5.02±0.01mg/100gm the minimum aluminum content recorded in T7 treated plants with average of 3.06±0.01 mg/100gm.

Zinc- Zinc is necessary to activates some of the enzymes in plant metabolism. Zinc content decreased due to water stress in T2, T4 and T7 treatments when compared to the control plants. The maximum zinc content was recorded in T2 treated plants with an average of 3.34±0.01mg/100gm, the minimum Zinc content was recorded in T7 plants with average of 2.32±0.001mg/100gm.

Phosphorous: It is an important constituent of every living cell and enters into the composition of phospholipids, nucleic acids, nucleo-proteins, co-enzymes like NAD and NADP, and even ATP. Levels of Phosphorus was also affected by water stress with maximum phosphorus content observed in T2 treatment with average of 1.52±0.01mg/100gm and minimum in T7 treatment with average of 1.25±0.01 mg/100gm when compared with that of the control 1.82±0.01.

Manganese: It plays an important role in activating some energy component of chlorophyll molecule. Manganese content decreased in all treatments which were subjected to water stress in T2, T4, and T7 treatments compared to the control plants. The maximum manganese content was recorded in T2 treated plants with an average of 2.18±0.01 mg/100gm and minimum manganese content recorded in T7 treated plants with average of 1.43±0.01 mg/100gm.

Table 1: Effect of water stress on plant height, Number of leaves, Root length, fresh weight of the root of *Andrographis paniculata.*

	Plant height **(cm) (mean± SD)**	Number of leaves **(mean±SD)**	Root length(cm) **(mean± SD)**	Fresh weight of the root**(gm) (mean±SD**
Control	69.33±0.70	69.33±2.12	17.65±0.005	1.38±0.05
T2 plants	68.33±0.70	62.33±2.01	19.58±0.05	1.32±0.05
T4 palnts	46.33±0.70	39.66±1.41	23.26±0.22	0.85±0.02
T7 plants	34.33±0.70	26.66±070	29.62±0.55	0.76±0.03

Table.2: Effect of water stress on minerals in *Andrographis paniculata* in different treatments.

S.no	Metals mg/100gm Dry weight	Control plants (mean±SD)	T2 plants (mean±SD)	T4 plants (mean±SD)	T7 plants (mean±SD)
1	Copper	0.39±0.01	0.38±0.01	0.28±0.01	0.25±0.01
2	Chromium	0.28±0.01	0.21±0.01	0.21±0.01	0.18±0.01
3	Iron	3.58±0.01	3.44±0.01	2.65±0.01	1.95±0.01
4	Aluminum	5.52±0.01	5.02±0.01	4.01±0.01	3.06±0.01
5	Zinc	3.83±0.01	3.34±0.01	3.06±0.01	2.23±0.01
6	Manganese	2.46±0.01	2.18±0.01	2.26±0.01	1.43±0.01
7	Phosphorous	1.82±0.01	1.52±0.01	1.52±0.01	1.25±0.01

DISCUSSION

Water stress is one of the most important environmental factors that regulate plant growth and development, which in turn affects the mineral content of the plants. As *Andrographis paniculata* is considered as medicinally important due to its anti-diabetic properties apart from other uses, analysis of mineral content is a prerequisite. Most of the medicinal plants were found to be rich in one or more mineral elements[15]. Subramanian [18] analyzed through atomic absorption spectrophotometer studies in medicinal plants revealed the presence of Fe and Mg as major elements and presence of Ca, P, K, Mg, Fe, Mn, Zn, and Ni in three different medicinal plants[1, 9, 10]. Similar studies were carried out by Gajalakshmi [7] to analyse minerals such as Ni, Cu, Cr, Zn, Pb in some medicinal plants. Phosphorus which plays a significant role in different physiological processes decreased with water stress which is in accordance with the studies made by Khalid[13]. Copper content found to be least affected by water stress even in T7 treated plants. Among the minerals analyzed in this study, all the minerals can withstand T2 water stress conditions, as the stress increases there was a decline in the mineral content. Sampat Ghosh[17] observed that *Glycyrrhiza* and *Andrographis* are good source of iron. *Tinospora*, *Andrographis* and *Boerhaavia* showed the presence of Vit.C, a good source of antioxidants, vitamins and macro and micro nutrients[15]. Similar observation was also made by Omar[16] were they observed reduced Fe(Iron) in *Vicia faba* under water stress conditions. The reduction of these nutrients in the leaves could also be attributed to transpirational rates. The decrease in the phosphorus induced by water deficit was also reported by Greenway[17].

CONCLUSION

Water stress acts as major criteria for development of any plant. Minerals analysed in this study showed a decrease in its content at different water stress levels. Decrease in mineral content reduced the overall development of the plant which in turn hindered metabolic pathways of major secondary metabolities which have medicinal properties. It could be concluded that water stress caused reduction in essential minerals which are necessary for maintenance of good health, thus effecting the usefulness and medicinal value of *Andrographis paniculata.*

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