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# Comparision of accumulation of organic and inorganic osmolyte in *Trianthema portulacastrum* L. growing in saline and non-saline habitats

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**ABSTRACT**

The present investigation was made to establish the role of osmolytes such as protein, proline, macro and micro elements in *Trianthema portulacastrum* L. growing in saline (man-made) and non-saline habitats of Baramati Tehasil (M.S.) India. Maximum concentration of above organic and inorganic osmolytes was observed in plants growing in saline habitats except concentration of $Fe^{3+}$. However, it also reveals that accumulation of organic and inorganic osmolytes confers ability to *Trianthema portulacastrum* L. collected from saline condition (man-made) to tolerate salt stress condition.

***Key words:*** *Organic and inorganic osmolytes, Saline and non-saline conditions, Trianthema portulacastrum L.*

## Introduction

The eco-physiological mechanisms of manysalt tolerant species have been studied by several plant physiologists (Khan *et. al*., 2004; Nedjimi, 2012) and most of them concluded that soil salinity, osmotic potential and soil moisture are important plant growth limiting factors. Plants protects themselves from salt toxicity by less $Na^+$ uptake and its transport to shoot and osmotic adjustment under saline conditions through inorganic uptake or synthesis of organic osmolyte or both (Munns, 2002). Many salt tolerant plant species cope with osmotic stress by synthesizing and accumulating some compatible solutes which are known as osmolytes (Ashruf and Foolad, 2007).

At present about 20% of the world's land under cultivation and about more than half of all irrigated land is affected by accumulation of salts (Zhu, 2001). Therefore, salt stress is one of major abiotic factor responsible for decrease in growth of plants which leads to decrease in crop yield (Munns, 1993; Gama *et. al*., 2007). To improve productivity of salt affected soil alongwith physical and chemical methods there is a strong need to identify natural salt absorbing plants. However, it is necessary to screen the some species growing in saline and non-saline condition along with osmolytes helping to them for tolerating salt stress. Lot of data are available on role of osmolyte to halophyte to thrive successfully and remove salts from saline soil. But there is a lacuna on information of potential use of plant species growing on (man-made) saline soil as a phytoremediation. So the present study explores the accumulation of organic and inorganic osmolytes in *Trianthema portulacastrum* L. growing in saline (man-made) and non-saline habitats to understand their mechanism to cope with salt stress and usefulness of study plant as a phytoremediator of saline soil.

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## Materials and Methods

Vegetative plant parts like leaves, stems and roots of *Trianthema portulacastrum* L. growing in saline and non-saline conditions were collected and analyzed for protein content by using the method of Lowry *et al.* (1951), free proline content was determined according to the method of Bates *et. al.* (1973), inorganic macro elements like sodium and potassium were estimated by using Flame photometer (Model 410 Corning, Germany) and the micro elements like $Ca^{2+}$, $Mg^{2+}$ , $Fe^{3+}$, $Mn^{2+}$, $Zn^{2+}$ and $Cu^{2+}$ were determined by using Atomic Absorption Spectrophotometer (A-Analyst 700 Perkin Elmer/ USA).

## Results

The material of *Trianthema portulacastrum* L. were collected from saline and non-saline condition and further analyzed for organic and inorganic osmolytes including four trace elements.

The comparative data of accumulation of organic osmolytesin *Trianthema portulacastrum* L. growing in saline and non-saline soil condition is tabulated in Table 1. The amount of protein and proline in plants growing in saline conditions is higher, i.e. 21.08% and 0.263% than those growing in non-saline conditions (15.20% and 0.216%). Accumulation of inorganic and trace elements in different plant parts like leaves, stems and roots of *Trianthema portulacastrum* L. growing in saline and non-saline soil condition is showed in Table 2 and 3. It showed same pattern of accumulation of organic osmolytes, i.e. its accumulation is higher in saline condition as compared to non-saline condition.

**Table 1.** Accumulation of organic osmolytes in *Trianthema portulacastrum* L. growing in saline and non-saline conditions

| Organic osmolytes | Percent | |
|---|---|---|
| | Non-saline condition | Saline condition |
| Proteins | 15.20 | 21.08 |
| Proline | 0.216 | 0.263 |

## Discussion

Since plants growing naturally under salt stress are good as forage for livestock's and or supplementary food for human being. Many plant researchers have worked on protein content in halophytes and mangoves (Malcolm, 1964; El-Shantnawi and Turuk, 2002). The present investigation showed that proteins in *Trianthema portulacastrum* L. fluctuated between 15.20 to 21.08%. Similar range of proteins (2.5 to 21.5) was reported in 7 mangrove species grown on Goa coast by Untawale *et al*., 1978. Mali (2016) recorded that the amount of protein is varied from 4.26 to 24.72% in *Pentatropis nivalis* growing in man-made (secondary salinized soil) saline soil from Baramati Tehasil. However, Frank and Lawrenz (1980) recorded comparatively greater concentration of protein (26-30%) in *Chenopodium album* and *Plantago major*. Sagar Kumar (1987) reported 7.2 to 26.4% alkali soluble protein in above ground parts such as leaves and stem of *A. manina*growing on Gujrat coast. Almost similar concentration of protein (21.08%) was recorded in study plant *Trianthema portulacastrum* L. collected from saline condition those collected from non-saline condition (15.20%). High nutritional value in terms of protein content in *Trianthema portulacastrum* L. in saline and non-saline condition recommends that it is a good source of human food and forage also.

*Trianthema portulacastrum* L. collected from saline soil condition showed more proline content than collected from non-saline soil condition. Similar results were recorded by Mali (2016). Early many researchers suggested that stress of salinity is responsible for accumulation of proline in halophytes (Stewart and Lee, 1974 and Joshi, 1986). Tipirdamaz

**Table 2.** Accumulation of inorganic elements in *Trianthema portulacastrum* L. growing in saline and non-saline conditions.

| Inorganic elements | Leaves | | Stems | | Roots | |
|---|---|---|---|---|---|---|
| | Non-saline condition (%) | Saline condition (%) | Non-saline condition (%) | Saline condition (%) | Non-saline condition (%) | Saline condition (%) |
| $K^+$ | 5.89 | 8.4 | 0.10 | 5.56 | 1.96 | 4.62 |
| $Ca^{2+}$ | 0.88 | 1.20 | 0.72 | 0.82 | 1.12 | 1.24 |
| $Mg^{2+}$ | 0.87 | 1.04 | 0.90 | 1.04 | 0.96 | 1.06 |
| $Na^+$ | 1.93 | 2.7 | 3.13 | 3.28 | 1.55 | 1.65 |

**Table 3.** Accumulation of trace elements in *Trianthema portulacastrum* L. growing in saline and non-saline conditions

| Trace elements | Leaves | | Stems | | Roots | |
|---|---|---|---|---|---|---|
| | Non-saline condition (%) | Saline condition (%) | Non-saline condition (%) | Saline condition (%) | Non-saline condition (%) | Saline condition (%) |
| $Fe^{3+}$ | .78 | .23 | .72 | .24 | .94 | .29 |
| $Mn^{2+}$ | .06 | 1.23 | .07 | 1.10 | .08 | 1.73 |
| $Zn^{2+}$ | .30 | .45 | .26 | .35 | .29 | .41 |
| $Cu^{2+}$ | .08 | .26 | .89 | .25 | .10 | .28 |

*et al.* (2006) worked on 50 halophytic species and reached to conclusion that proline and glycine betain behaves as almost omnipresent osmolyteandits usefulness in salt tolerance. The proline may have role in osmotic adjusted under adverse condition of salt stress. Mali (2016) working on *Pentatropis nivalis* showed same observations and similar observations are also showed by Ricardo*et. al.* (2014) while working with five succulent halophytes.

It is generally recognized that the process of osmotic adjustment in plant subjected to salt stress achieved by absorption and accumulation of monovalent cation $Na^+$ and anion $Cl^-$in shoots (Munns *et al.*, 1983). Thus, inorganic ions useful in maintaining internal osmotic potential facilitating absorption of water but some of the ions may be harmful to enzymes. According to Walter (1961) halophytes regulates their internal osmotic balance adaptive mechanisms like exclusion, accumulation, excretion and succulence. Results of accumulation of inorganic elements such as $Na^+$, $K^+$, $Ca^{2+}$ and $Mg^{2+}$ in leaves, stems and roots of *Trianthema portulacastrum* L. growing in saline and non-saline condition have been presented in Table 2. All these minerals occurred in greater concentration in leaves, stems and roots collected from non-saline conditions.Present investigation further indicated greater content of $K^+$ than $Mg^{2+}$ with exceptions. Similar observations were made by Mali (2016) while working on seasonal variations in accumulation of organic and inorganic osmolytes in *P. nivalis* climber growing in Baramati Tahsil. In contrast, Albert and Popp (1977) suggested that a few plants growing under saline condition accumulated greater quantity of $Mg^{2+}$than $K^+$. Potassium, which plays a important physiological role in plant is also associated with the salt tolerance of halophytes (Larsen, 1962 and Churputkar, 1969). According to Hasaegawa *et al.* (2000) physiology of absorption and accumulation of $K^+$in halophytes has remained one of the most interesting field of research because of fact that external $Na^+$negatively affects intracellular $K^+$influx attenuating acquisition of this essential nutrient by cell. However, Epstein (1972) reported that the adequate level of $K^+$ in plant accounts for 0.5% (0.26 meq.$q^{-1}$) of dry weight and interestingly halophytes and mangroves are endowed with exceptional potential for its enough absorption and $Na^+$rich conditions. Potassium content in *Trianthema portulacastrum* L. varied between 0.10 to 8.40%. Further, it was found that leaves accumulated more $K^+$as compared to stems and roots. Similar observations were made in accumulation of potassium in *P. nivalis* (Mali, 2016). Thus, the present investigation suggested that the potassium accumulating capacity of *Trianthema portulacastrum* L. fluctuated significantly.

Findings on accumulation of trace elements ($Fe^{3+}$, $Mn^{2+}$, $Zn^{2+}$ and $Cu^{2+}$) in *Trianthema portulacastrum* L. collected from saline and non-saline conditions are represented in Table 3. Mineral metabolism in plants growing in saline habitats has remained interesting field for plant physiologist. Limited information is available on trace elements in halophytes. The present research showed higher accumulation of $Mn^{2+}$, $Zn^{2+}$ and $Cu^{2+}$ in *Trianthema portulacastrum* L. collected from non-saline soils but such trend was not observed in case of accumulation of $Fe^{3+}$. Similar observations in case of accumulation of $Zn^{2+}$ and $Cu^{2+}$ was observed in leaves of *Salvadora porsica* subjected to various concentrations of Nacl, $Na_2SO_4$and seawater (Joshi *et. al.*, 2005). Quite similarly, the composition of trace elements in *A. hymenelytra* was not affected by three concentrations of NaCl in growth media (Soufi and Wallace, 1982). Thus, the present investigation adds interesting information of salt stress on accumulation of trace elements in *Trianthema portulacastrum* L.

## Conclusion

The concentrations of organic, inorganic and trace elements are found more in *Trianthema portulacastrum* L. growing in saline condition as compared to non-saline condition. Furthermore, it can be concluded that *Trianthema portulacastrum* L. may be used as phytoremediation of primary and secondary saline soils, high nutritional values in term of protein content in saline and non-saline conditions recommends that it is a good source of forage and human food too. High proline concentration in *Trianthema portulacastrum* L. under salt stress condition showed that this species belongs to proline accumulating group of halophytes.

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