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RESEARCH ARTICLE

MINERAL CONTENT OF CHICKPEA UNDER THE INFLUENCE OF PETAL LEACHATE OF *DELONIX REGIA* (BOJ EX HOOK) RAF

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ABSTRACT

Nutritional status of plants has important role in increasing yield and quality of crop plants. Macronutrients and micronutrients are essential elements for metabolism of plants. Influence of aqueous leachate (at 20% and 0.01% concentration) of dried and dropped petals of *Delonix regia* (Boj Ex Hook) Raf was studied on mineral contents of seedlings of Chickpea (*Cicer arietinum* L. var. Kalyani) in petriplate and soil bioassays under laboratory conditions. Petal leachate increased content of phosphorus except at lower concentration in soil bioassay. Sodium and magnesium were decreased in seedlings in petriplate bioassay while increased in soil bioassay. Petal leachate reduced the level of calcium. In petriplate bioassay potassium content was increased at lower concentration and in soil bioassay it was increased at higher concentration. There was decrease in iron content at both concentrations and in both bioassays. Manganese and zinc were decreased in seedlings in petriplate bioassay and increased in soil bioassay at high and low concentrations of petal leachate. The alterations in mineral contents may lead to further metabolic disorders in the petal leachate treated Chickpea seedlings

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INTRODUCTION

Plant nutrition is one of the most important problems in crop production which have important role in crop production and improve quality of agricultural products. For suitable plant nutrition every element should be in enough amount for plant growth and balance and respect the ratio between used nutrients is also important (Alloway, 2008). In agricultural development programs role of micronutrients is very important to increase crop yield and quality (Mousavi *et al*., 2011). Allelopahty also played important role in various types of stress conditions of environment including soil nutrient inadequacy (Xiao *et al*., 2007). Jabran *et al.* (2013) have concluded that allelochemicals play a role in regulation of plant nutrition. When these are released into rhizosphere, involved in solubilization, utilization, liberation and chelation of mineral elements. Phenolic compounds are involved in alterations of availability of mineral elements in rhizosphere and organic matter dynamics (Makoi and Ndakidemi, 2007). Due to reduction in mineral uptake changes in cellular membrane functions of plant roots due to alterations in the permeability of membranes to mineral ions are observed (Balke, 1985). Mineral elements are having various roles in plant metabolism as structural components in macromolecules, as cofactors in enzymatic reactions, as osmotic solutes needed to maintain proper water potential or as ionized species to provide charge balance in cellular compartments (Grusak, 2001). It was reported by Kruse (2000) that the water relations of the plant and the formation of root hairs are affected by allelochemicals. Due to this the uptake and transport of mineral nutrients has been altered as phenolic acids are involved in the formation of complexes with plant nutrients. Chickpea (*CIcer arietinum* L.) has been considered as an important legume crop having high nutritive value. It is preferred by the people in developing countries due to its protein content and energy. Ibricki (2003) has been reported that chickpea was a good source of Ca, Mg, K, P, Fe, Zn and Mn. Traditionally it has been cultivated in saline soils in arid and semiarid regions (Rao *et al*. 2002). *Delonix regia* is used for plantation along roadsides as a shade tree. It can also be planted for fencing purpose (Orwa *et al*. 2009).Throughout the country the tree is recommended for the agro forestry programme. Every tree is following frequent shedding of leaves and flowers. Therefore it was thought worthwhile to study influence of petal leachate of *D. regia* on mineral content of Chickpea seedlings.

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MATERIALS AND METHODS

Dried and dropped petals of *D. regia* were collected from lines of streets and farm side in Kolhapur District (Maharashtra

State, India) in the month of April and May in 2013. Seeds of Chickpea (*Cicer arietinum* L.) var. Kalyani (Prerana Seeds) were procured from local market. The method given by Jadhav and Gaynar (1992) was followed for the preparation of petal leachate. Ten grams of petals were washed with distilled water for 4-5 times to remove surface dust. The petals were soaked in 50 ml of distilled water for 24 hours and filtered through Whatman No.1 filter paper and then it was diluted to 0.01% concentration. Petal leachates (20% and 0.01%) were used for further treatment. Healthy seeds of Chickpea were surface sterilized by treating with 0.1% $HgCl_2$ for 5 minutes. The seeds were rinsed with distilled water for 4-5 times. Ten seeds were placed in sterilized petriplates (having diameter of 9 cm) with moistened filter paper. In each petriplate 8 ml of petal leachate (20% and 0.01%) was added. The petriplates supplied with distilled water served as control. The petriplates arranged in triplicates for each treatment. Seeds were kept for germination at temperature range 24-28^{0}C under natural light and dark cycles and 120 hours old seedlings were used for further analysis. Soil bioassays were carried by using plastic trays having dimension (22cm X 17cm X 4.2cm). In each tray 750 grams of soil was added and it was moistened with distilled water. Thirty seeds were sown in tray. Fifty ml of petal leachate was applied for 5 days (at alternate day). Then intact seedlings (10days old) were uprooted carefully and used for further analysis. Seedlings were allowed to dry till constant dry weight was obtained. For the preparation of acid digest method given by Toth *et al*. (1948) was followed. Five hundred mg of oven dried powder was treated with 20 ml concentrated HNO_3 for about 15 minutes. It was heated slowly on hot plate to dissolve solid particles. Mixture was cooled to room temperature and 10 ml 60% Perchloric acid was added to it. Again the mixture was heated on hot plate till 2-3 ml clear and colorless concentrate was obtained. The volume of digest was adjusted to 100 ml with distilled water, was kept overnight and next day filtered through Whatman No. 1 filter paper. This acid digest was used for estimation of macro and microelements. For the detection of elements like Calcium, Magnesium, Manganese, Iron and Zinc Atomic Absorption Spectrophotometer (Perkin Elmer 3030) was used and for Potassium and Sodium Flame photometer was used. For the estimation of phosphorus method given by Sekine *et al*. (1965) was followed. Acid digest was treated with 2N HNO3 and Molybdate Vanadate reagent and absorbance of yellow colored complex was recorded at 420nm. Amount of phosphorus was determined by using calibration curve of standard phosphorus.

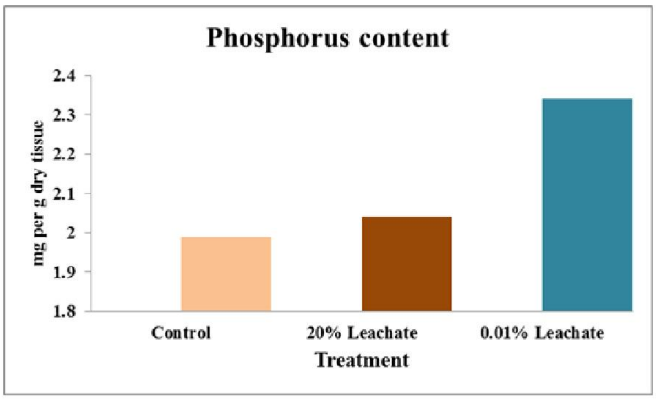
RESULTS AND DISCUSSION

Macronutrients

Phosphorus

Phosphorus content was increased in seedlings of Chickpea in both petriplate and soil bioassays due to treatment of petal leachates. Decrease in 'P' content was observed in seedlings in soil bioassay due to 0.01% petal leachate (Fig.1). In cowpea seedlings also phosphorus content was decreased due to caffeic acid, protocatechuic acid and syringic acid (Alsaadawi *et al*., 1986). Kabra and Einhellig (1987) concluded that in roots and shoots of *Sorghum* seedlings phosphorus content was reduced due to 0.25mM and 0.5mM ferulic acid at 3 and 6 harvests. Maulood and Shireen (2012) have carried out experimnets on effect of different concentrations of residues of dill (*Anethum graveolens*) on two types of Barley cultivars (Tedmor and Barbara) and concluded that content of 'P' was increased in leaves of both cultivars due to increasing concentrations of residue of dill plant. Kami land and Sumeia (2014) found increase in 'P' uptake in leaves of maize cultivar 5018A due to mulching treatment of dried bark, leaves and stems of *Dodonaea viscosa*. In stems and roots of seedlings of pine phosphorus was increased due to soil mixed with litter of Aleppo pine and soil with mixed litter of Aleppo pine and Holm oak (Hamana and Hocine, 2014). As 'P' is a component of ATP, it is involved in energy transfer (Hawkesford *et al*. 2012). It also supplies metabolic energy in photosynthesis and respiration because phosphate group is attached to many sugars (Grusak, 2001). Organic phosphate compound phytin is mainly present in seeds. During germination of seeds phytin is mobilized and converted into other phosphate compounds which are utilized in the metabolism of young plants (Bewley and Black, 1994).

Petriplate bioassay



Soil bioassay

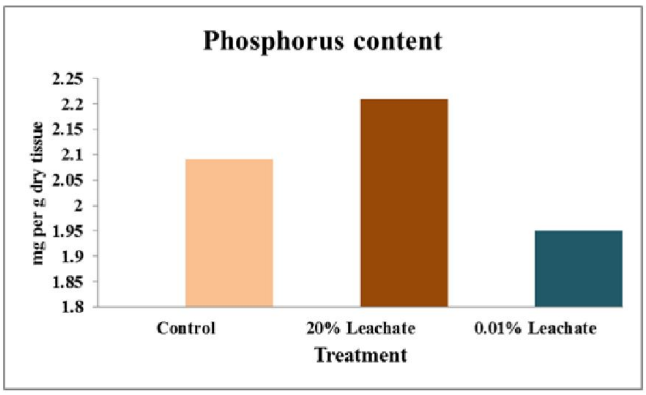


Fig. 1. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Phophorus content in seedlings of Chickpea (*Cicer arietinum* L.)

Potassium

In Chickpea seedlings Potassium content was increased at low concentration of petal leachate in petriplate bioassay and at high concentration of leachate in soil bioassay (Fig.2). In

Petriplate bioassay

Soil bioassay

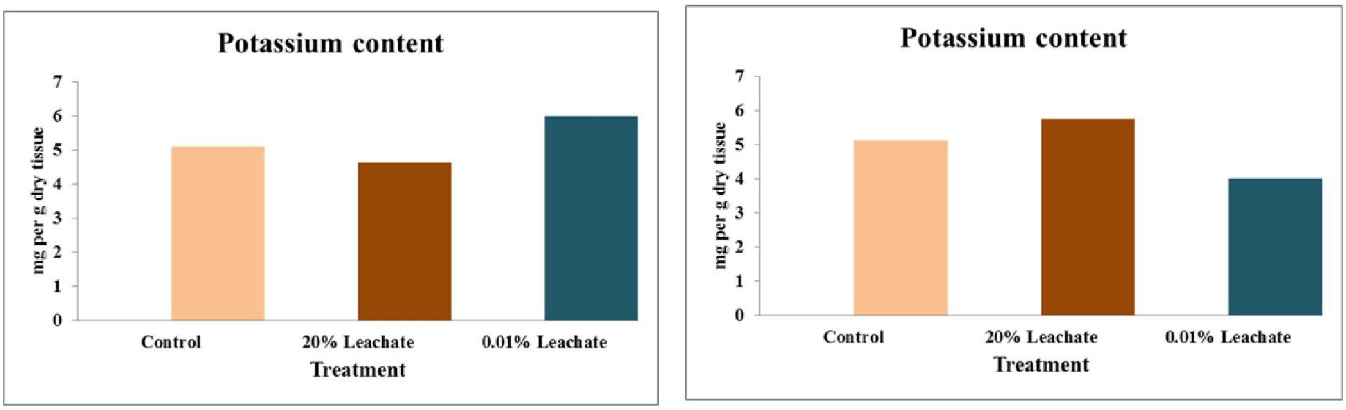


Fig. 2. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Potassium content in seedlings of Chickpea (*Cicer arietinum* L.)

Petriplate bioassay

Soil bioassay

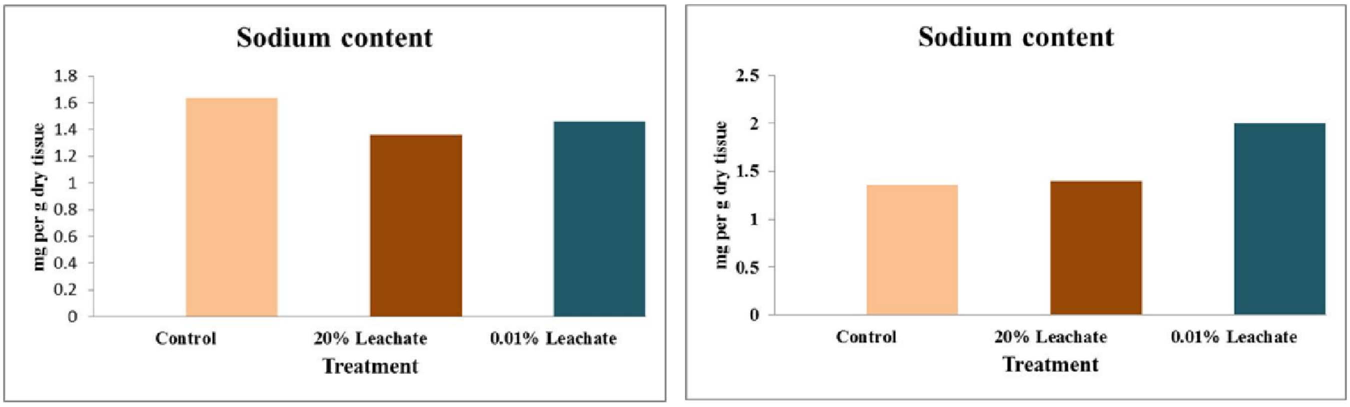


Fig. 3. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Sodium content in seedlings of Chickpea (*Cicer arietinum* L.)

Petriplate bioassay

Soil bioassay

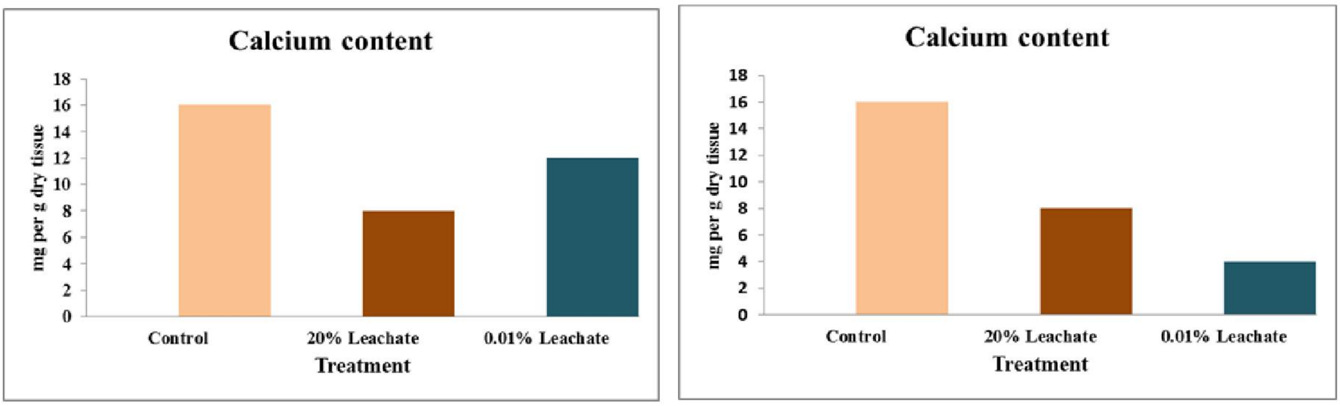


Fig. 4. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Calcium content in seedlings of Chickpea (*Cicer arietinum* L.)

cowpea seedlings potassium content was declined due to treatment of caffeic, protocatecuic and synergic acids (Alsaadawi *et al.,* 1986). Kabra and Einhellig (1987) noticed that in roots and shoots of Sorghum (*Sorghum bicolor*) concentration of potassium was lower at the 3 and 6 day harvests when 2 weeks old seedlings were treated with 0.25mM and 0.5mM ferulic acid. Yu and Matsui (1997) have reported that root exudates of cucumber inhibited uptake of potassium by intact cucumber seedlings. Maulood and Shireen (2012) have noted that potassium content was increased in leaves of two cultivars of Barley (Tedmor and Barbara) due to increasing concentration of residue of *Anethum graveolens*. In leaves of maize cultivar 5018A potassium content was increased due to incorporation of plant parts like bark, stems and leaves of *Dodonaea viscosa* (Kamil and Sumeia, 2014). It was reported by Hamana and Hocine (2014) that in stems and roots of seedlings of pine potassium content was increased due to litter of Aleppo pine and mixed litter of Aleppo pine and Holm oak. Potassoim is involved in maintainance of osmotic

Petriplate bioassay

Soil bioassay

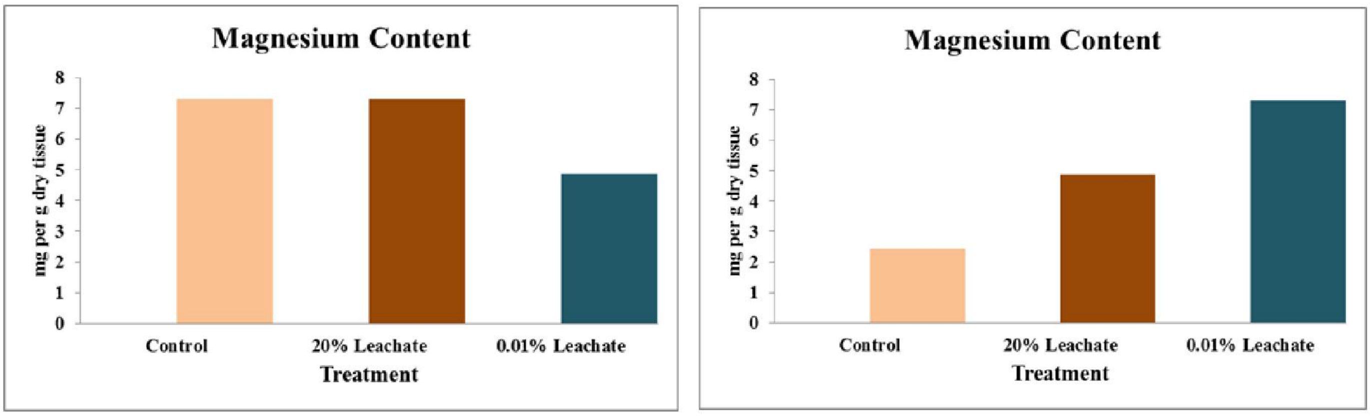


Fig. 5. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Magnesium content in seedlings of Chickpea (*Cicer arietinum* L.)

Petriplate bioassay

Soil bioassay

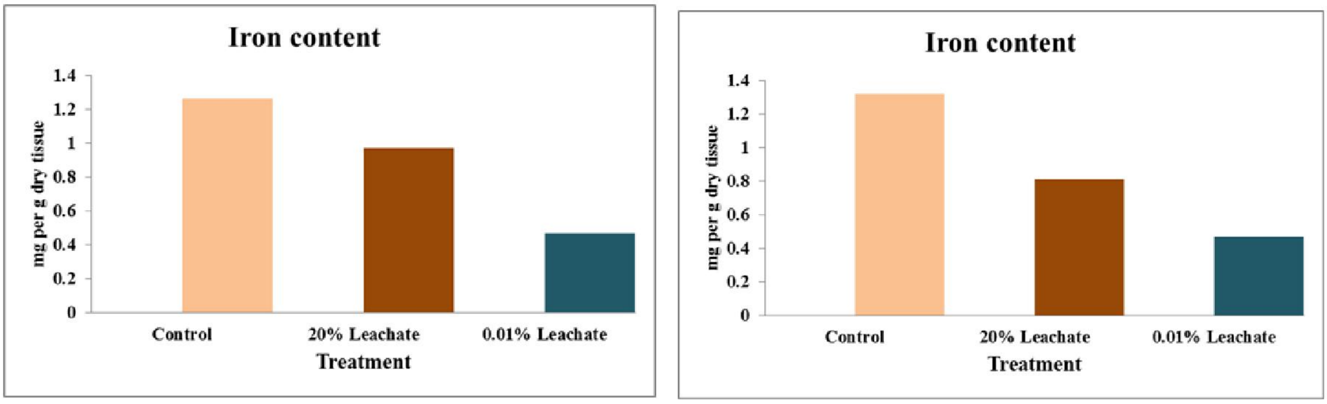


Fig. 6. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Iron content in seedlings of Chickpea (*Cicer arietinum* L.)

Petriplate bioassay

Soil bioassay

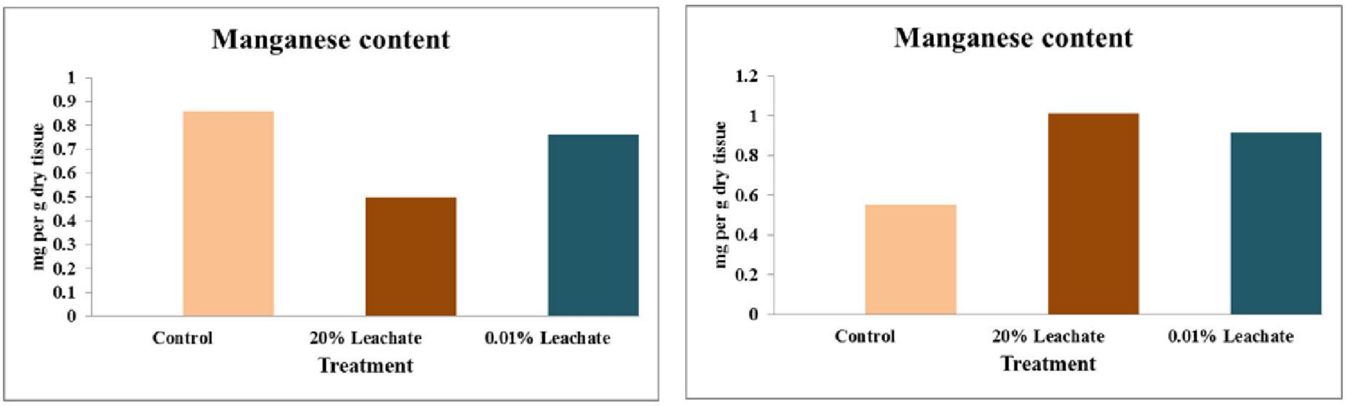


Fig. 7. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Manganese content in seedlings of Chickpea (*Cicer arietinum* L.)

potential of cells. Extension and growth of cells also affected by potassium. It plays a role in membrane transport of numerous chemical constituents (Grusak, 2001). Potassium plays a role in water uptake by cells and tissues, in activation of various enzymes, ATP synthesis, CO_2 assimilatoin and mobilization of stored material.

Sodium

No significant change in Sodium content was observed due to treatment of petal leachate except in soil bioassay where 'Na' content was increased due to 0.01% petal leachate (Fig. 3). As sodium is having similarity with potassium, potassium is substituted by sodium as cofactor for certain enzymes, as osmoregulator as well as in stomatal movement and cell expansion (Pilon- Smits *et al*. 2009).

Calcium

In both bioassays calcium content was decreased due to petal leachates at lower as well as at higher concentration in chickpea seedlings. Higher decrease in 'Ca' content was observed in seedlings in soil bioassay due to 0.01% petal leachate (Fig.4). In seedlings of Cucumber uptake of calcium was also reduced due to root exudates of cucumber (Yu and Matsui1997). Calcium plays various structural roles in the cell wall and membranes (White and Broadley, 2003). It is involved in membrane functioning as in ion uptake and metabolic processes (Marschner, 1986). It is also essential for cell elongation and cell division (Burstrom, 1968).

to treatment of extract of both stem and leaves of *Dodonaea viscosa*. Iron plays an important role in photosynthesis, development of chloroplast and biosynthesis of chlorophyll. It is an integral part of cell redox system as heme proteins. For many enzyme systems it functions as prosthetic group.

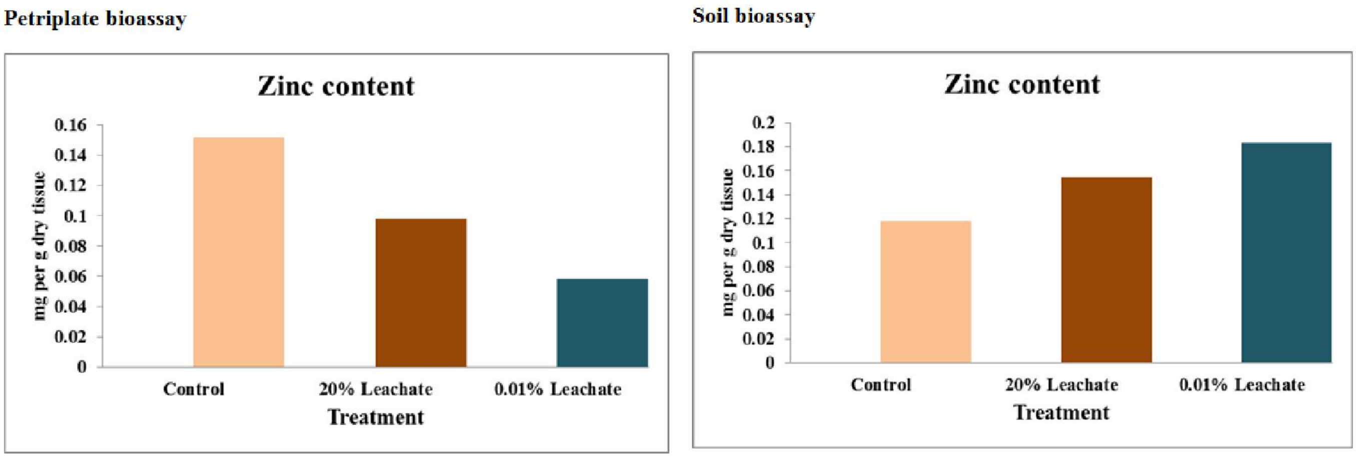


Fig. 8. Influence of petal leachate of *Delonix regia* (Boj Ex Hook) Raf. on Zinc content in seedlings of Chickpea (*Cicer arietinum* L.)

Magnesium

Magnesium content in seedlings of Chickpea was decreased due to petal leachate treatment in petriplate bioassay while it was increased in soil bioassay. High increase was observed in seedlings in soil bioassay due to petal leachate at low concentration (Fig. 5). Baziramakenga *et al*. (1994) indicated that magnesium content was decreased in root tissue and accumulated in shoot tissue of Soybean due to treatment of benzoic acid and cinnamic acid. Kabra and Einhellig (1987) observed that in roots of *Sorghum* magnesium content was reduced at 0.25mM and 0.5mM ferulic acid at both 3 and 6 day harvest. Root exudates of cucumber inhibited the uptake of magnesium by intact cucumber seedlings (Yu and Matsui1997). Various types of enzymes and enzyme reactions including phosphatases, ATPases and carboxylases are fostered by magnesium. It is also involved in synthesis of ATP and protein (Gursak, 2001).

Micronutrients

Iron

Iron content was decreased due to petal leachate treatment in both petriplate and soil bioassays. Higher decrease in iron content was observed due to 0.01% petal leachate (Fig. 6). Iron content was reduced in roots of *Sorghum* due to treatment of ferulic acid at 3 day harvest (Kabra, and Einhellig 1987). Alsaadawi *et al*. (1986) noticed that iron content was reduced in cowpea sedlings due to treatment of caffeic, protocatechuic and synergic acids. Yu and Matsui (1997) reported that in intact cucumber seedlings iron uptake was inhibited due to root exudates of cucumber. Kamil and Sumeia (2014) found increase in iron content in leaves of maize cultivar 5018A due

Manganese

In Chickpea seedlings 'Mn' content was decreased in petriplate bioassay and it was increased in soil bioassay due to treatment of petal leachate (Fig. 7). Manganese is involved in redox reactions. It works as a cofactor and in activating several enzymes involved in catalysis of oxidation, reduction, decarboxylation and hydrolytic reactions (Grusak, 2001).

Zinc

Zinc content was decreased in seedlings due to treatment of petal leachate in petriplate bioassay and it was increased in soil bioassay. More increase and decrease in 'Zn' content was observed due to petal leachate at lower concentration (Fig.8). Due to treatment of extract of *Ageratum conyzoides* L., *Melilotus indica* All. and *P. hysterophorus* L. uptake of zinc was also reduced in three varieties of Paddy (*Oryza sativa* L.) PD-10, PD-12 and PB (Saxena *et al.*, 2004). Zinc plays a role in starch formation (Jyung *et al*., 1975). It acts as structural component of enzymes like alcohol dehydrogenase, carbonic anhydrase, superoxide dismutase and RNA polymerase (Grusak, 2001). Phosphorus is involved in energy transfer as well as it supplies metabolic energy for various processes in the plants. Alterations in 'P' content may pose limitations on energy transfer in chickpea seedlings. Potassium is involved in maintenance of osmotic potential of cell and in extension and growth of cells. Growth of chickpea may be affected due to reduction in 'K' content due to petal leachate treatment. Reduction in calcium content in chickpea seedlings may also affect further growth as it is essential for cell elongation and cell division. Magnesium is involved in activation of various types of enzymes and enzyme reactions and also in synthesis of ATP and protein. Iron plays a role in photosynthesis, development of chloroplast and biosynthesis of chlorophyll and also acts as prosthetic group for many enzyme systems. Manganese works as a cofactor and in activating several enzymes. Zinc is involved in starch formation and acts as structural component of some enzymes. Due to alterations in contents of Mg, Fe, Mn and Zn in chickpea seedlings due to petal leachate further metabolism of seedlings may be affected and due to disturbances in metabolism of seedlings further growth and development of chickpea may be affected.

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