# HYPER ACCUMULATION AND SOIL ENRICHMENT OF CERTAIN INORGANIC NUTRIENTS BY SOME PLANTS FROM MEERUT

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The present paper aims to investigate the absorption and accumulation potential of some mineral nutrients by the selected plants (*Calotropis procera, Cissus quadrangularis* and *Cassia fistula*) from the soil that are also beneficial for human health. The differences in uptake and absorption potential of the minerals (N, P, K, Ca, Na, Cu and Fe) by the plants also demonstrates the varying requirement of these essential minerals for their development as well as their varying potential to act as hyper-accumulators. The study exhibited maximum accumulation of N, Fe and Na content in *C. procera* (stems) whereas maximum Ca , P, Cu content in *C. quadrangularis* (leaves) while K content in *C. quadrangularis* (internodes). All these plants enriched soil with studied minerals except for depletion of Fe by *Cassia fistula*, P by *C. procera* and Fe and P both by *C. quadrangularis.*

**Keywords**- Micronutrients, Macronutrients, *Calotropis procera, Cissus quadrangularis* and *Cassia fistula*

Minerals are of prime importance for the human health. The importance of minerals such as Potassium, Calcium, Sodium etc. to the human health is well known. Required amounts of these elements must be in human diet to pursue good healthy life (San *et al.* 2009). Trace amounts of some metals for example manganese, copper and zinc are essential as micro nutrients and have a variety of biochemical functions in all living organisms (Manuel *et al*. 2004 and Peris *et al.*1996). The content of mineral elements in plant depends to a high degree on the abundance in soil including the intensity of fertilization. A number of mineral elements are required in varying amounts by humans for proper growth, function and overall well -being (Obiajunwa *et al*. 2005 and Hursain *et al.*2010)

Mineral nutrients are divided into two broad groups- Major and trace elements. Major minerals represent 1% of bodyweight and are required in amounts greater than 100mg per day, while trace minerals make up less than 0.01 percent of body weight and are essential in much smaller amounts. It is estimated that 70 biological elements are needed by all living things for normal function of their metabolism, reproductive and immune system (Ozcan, 2004). More than 30 mineral elements have been found with different key functions in helping plant and animals to survive and live healthy. As a direct result, they have always attracted the attention of Scientists (Nardana *et al.* 2013).

Many elements in trace amounts, play a vital role in metabolic processes and are essential for the general well-being of humans (Kumar *et al*. 2004). The elements activate the enzymes thereby influencing biochemical processes in cells in an essential way (Lozak *et al.* 2001). Several elements such as Na, K, Mg and Mn are present at mg/g level, whereas elements such as Cr, Fe, Co, Ni, Cu, Zn and Cd are present at a few μg/g. Glycophytic plants such as beets, celery, turnips and spinach can utilize Na to such a degree that it is possible for farmers to substitute relatively inexpensive Na salts as fertilizer in place of the more expensive K fertilizer (Marschner 1971). In addition, some rare elements have been reported at the ng/g level (Cao *et al*. 1998). The content of essential elements in plants seems to be conditional, being affected by the geochemical characteristics of the soil and by the ability of plants to selectively accumulate some of these elements (Miroslawski *et al.* 1995). Several factors directly or indirectly influence the levels of minerals in plants and hence the amounts available for humans and animals that depend on plants for food and feed,

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respectively. The amount of a particular nutrient in the diet may be insufficient to meet the requirements. However, the metabolism of the animal may be deranged by the interaction of dietary, environmental and genetic factors (Gordon 1977).

## MATERIAL AND METHODS

### Material

All the chemicals used were of Analytical grade (Sigma) and the glasswares, containers, prior to their use were washed with the liquid detergent and further rinsed with the deionized water. The glasswares were kept in oven at 100$^0$C for about 48 hours. For overall estimations deionized water is used. The stock solutions of the respective minerals (P, N, K, Ca, Na, Cu and Fe) were prepared in ppm for making calibration curves.

### Samples

Three locally available plants (*Calotropis procera, Cissus quadrangularis* and *Cassia fistula*) from the Botany Department of C.C.S.University, Meerut, were used to obtain the different plant part samples (stem and leaf). Of these, *C.procera* was in flowering stage (March) and rest two were in mature vegetative stage (during July- August).The soil samples were also collected from the same site as well as 1 m away from that site (Table-1) for determining crude mineral uptake, depletions or enrichment of soil during one month's period.

### Digestion of the Sample

Prior to digestion the plant parts were washed with deionized water and were allowed to dry in oven at 100$^0$C for about 48 hours and further crushed to form powder for the digestion and estimation. 100mg of plant and soil samples each were digested using 5ml Aqua regia. The digested samples were then filtered using Whatman filter paper No. 1 and prepared finally in the ratio 1:9 using deionized water. For the analysis of minerals Flame Photometer (Systronics), Atomic Absorption Spectrophotometer (LabIndia AA7000) and UV Visible Spectrophotometer (Shimadzu UV-1800) were used.

## RESULTS AND DISCUSSION

The results for micro and macro-mineral analysis were obtained by using Flame Photometer for Na (Fig. 7), K (Fig. 2) and Ca (Fig. 3), AAS for Fe (Fig. 5), Cu (Fig. 6) and UV Visible Spectrophotometer for N (Fig. 1) and P (Fig. 4), respectively as summarized in Table-1 in mg/g dry weight. Each calculated value in the result is the average of at least 3 independent values along with Standard Deviation. According to Taylor *et al.* (1998), the extract of *C. procera* is rich in K, Mg, Na and Ca contents. The present study showed N content (13.53±0.03mg/gm dry wt.), Fe content (0.031±0.005mg/gm dry wt.) and Cu content (23.50±0.86mg/gm dry wt.) in *C.procera* (stems). A study on elemental profile by Udaykumar *et al*. (2004) clearly depicts that estimated calcium content in *C. quadrangularis* stem is (1.76g/100gm) followed by leaf (1.68g/ 100gm) and root (1.51g/100gm).Our studies indicated Ca content (13.38±0.55mg/gm dry wt.), P content (0.074±0.84mg/gm dry wt.), Na content (0.014±0.005mg/gm dry wt.) in *C. quadrangularis* (leaves) while K content (4.58±0.0mg/gm dry wt.) in *C. quadrangularis* (internodes). As per the quantitative estimation by Kumar *et al.* (2015) the calcium content in 5gm dried plant part of *Cassia fistula* is18000ppm and phosphorus is 15100ppm which is quite unjustified as per our analysis. Thus, the obtained data reveals that different plants possess varying capability of uptaking and accumulating the minerals from soil. From the above data collected and analysed it can also be inferred that besides having medicinal properties these plants are also capable of uptaking and accumulating the minerals that too are important for their development as well as for humans. Besides, plant enrichment with

**Figure 1:** Nitrogen (N) and Potassium (K) contents in the plant and soil samples

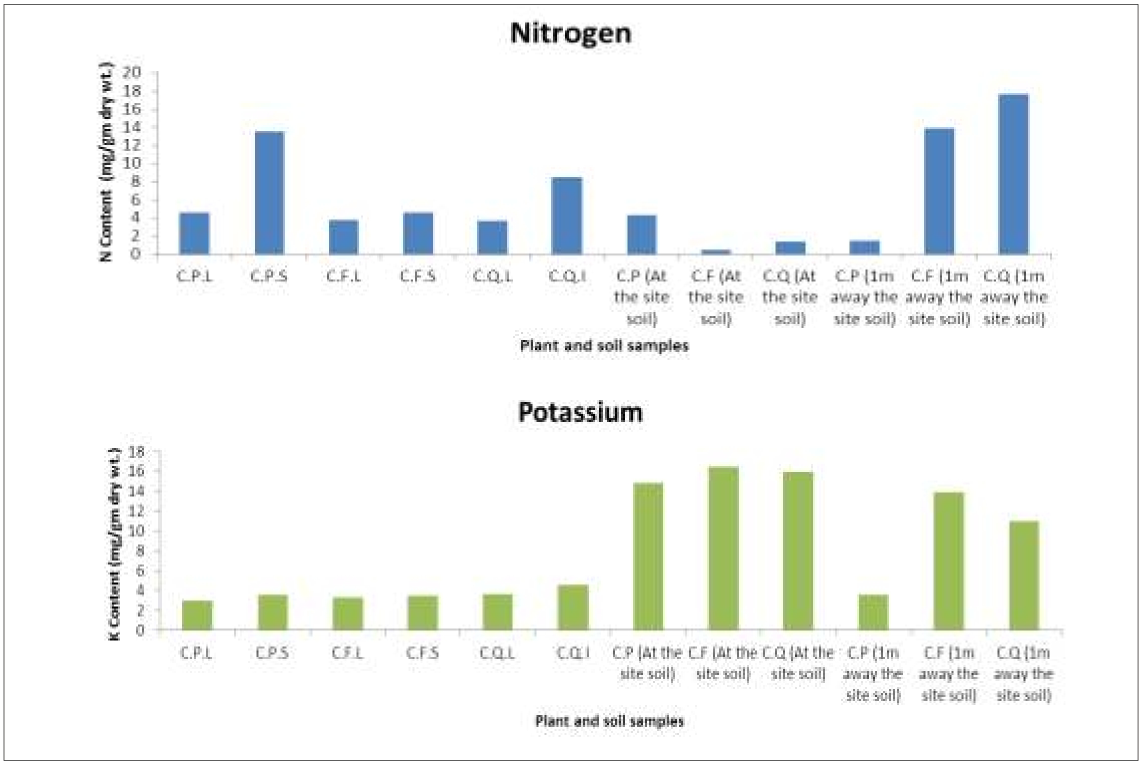



**Figure 2:** Calcium (Ca) and Phosphorus (P) contents in the plant and soil samples

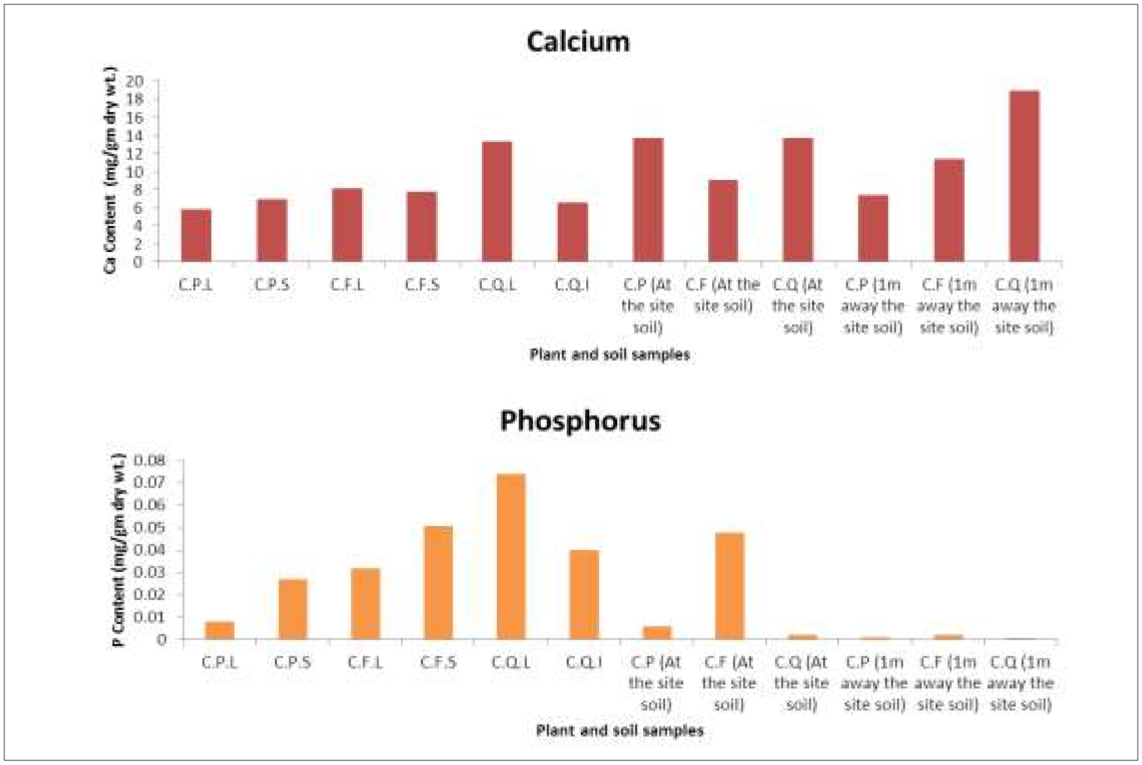
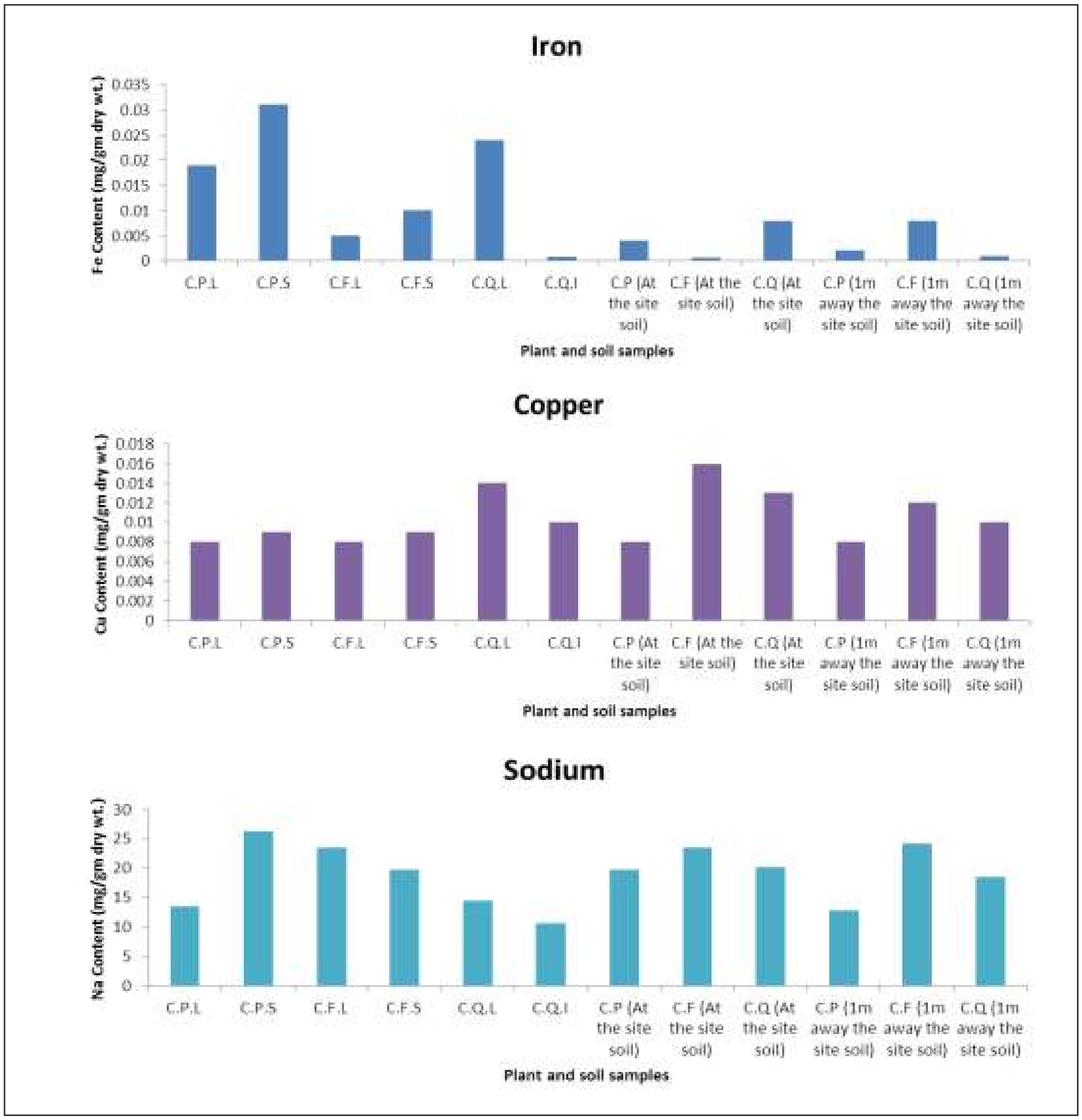


**Figure 3:** Iron (Fe), Copper (Cu) and Sodium (Na) contents in the plant and soil samples




Where C.P.L (*Calotropis procera* Leaf), C.P.S (*Calotropis procera* Stem), C.F.L (*Cassia fistula* Leaf), C.F.S (*Cassia fistula* Stem), C.Q.L (*Cissus quadrangularis* Leaf) and C.Q.I (*Cissus quadrangularis* Internode)

required minerals, the soil around the plant and 1m away from the plant was also enriched in most of the studied minerals except Fe in case of *C.fistula* and *C. quadrangularis* and P in case of *C. procera* and *C. quadrangularis*, suggesting the overutilization of these minerals by the said plants in their metabolism.

## CONCLUSIONS

This study has shown the preference in uptake and accumulation of Cu, Ca and P by *C. quadrangularis* leaves and N, Fe and Na by *C. procera* stem. Out of the 3 plants (*C. procera, C. fistula* and *C. quadrangularis)* used for the study, the leaf part of *C. quadrangularis* and stem part of *C. procera* accumulated more of the said minerals (N, P, K, Ca, Na, Cu and Fe) besides enriching the soil around (1m) by hyperaccumulation of these minerals in the soil. These nutrients in biocompatible forms can be beneficial for the treatment of mineral deficiency diseases. However, the reports of numerous papers indicate that internodal part

**Table 1:** The overall uptake of Minerals (N, P, K, Ca, Na, Cu and Fe) and Soil Enrichment by the selected plants (*Calotropis procera, Cissus quadrangularis* and *Cassia fistula)* in one month

| S. No. | Plants | Elements | In plants (Leaf + Stem Node/Internode) | In Soil (At the Site) | In Soil (1m away from site) | Mechanism involved |
|---|---|---|---|---|---|---|
| 1. | *Cassia fistula* | N | + | - | + | Uptake |
| 2. | | K | + | + | + | Uptake and Enrichment |
| 3. | | Ca | + | + | + | Uptake and Enrichment |
| 4. | | P | + | + | - | Uptake and Enrichment |
| 5. | | Fe | ~+ | - | + | Uptake |
| 6. | | Cu | + | + | + | Uptake and Enrichment |
| 7. | | Na | + | + | + | Uptake and Enrichment |
| 8. | *Calotropis procera* | N | + | + | - | Uptake and Enrichment |
| 9. | | K | + | + | - | Uptake and Enrichment |
| 10. | | Ca | + | + | + | Uptake and Enrichment |
| 11. | | P | + | ~+ | - | Uptake and Enrichment |
| 12. | | Fe | + | + | ~+ | Uptake and Enrichment |
| 13. | | Cu | + | + | + | Uptake and Enrichment |
| 14. | | Na | + | + | + | Uptake and Enrichment |
| 15. | *Cissus quadrangularis* | N | + | - | + | Uptake |
| 16. | | K | + | + | + | Uptake and Enrichment |
| 17. | | Ca | + | + | + | Uptake and Enrichment |
| 18. | | P | + | - | - | Uptake |
| 19. | | Fe | + | ~+ | - | Uptake and Enrichment |
| 20. | | Cu | + | + | + | Uptake and Enrichment |
| 21. | | Na | + | + | + | Uptake and Enrichment |

(+) Maximum Accumulation, (-) Minimum Accumulation and (~+) Moderate Accumulation

of *C. quadrangularis* maximally accumulates Ca and thus can be used for the cure of joint pain (Enechi and Odonwodo 2003) but as per our studies in the vegetative phase, *Cissus quadrangularis* leaves were found to be more efficient in accumulating Ca rather then internodes. Such studies might provide some basis for exploration of plants for treatment of mineral deficiency related diseases.

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