AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly e Newsletter
Volume 2 – Issue 5
Online ISSN: 2582-368X
www.agriallis.com

MOLYBDENUM: ESSENTIAL ELEMENT FOR PLANTS AND ANIMALS

Article Id: AL202067

Baljeet[1]*, Sanjeev Kumar[1], Santosh Onte[1]and Magan Singh[1]

Agronomy Section, ICAR-National Dairy Research Institute, Karnal, Haryana- 132001

Email: baljeetkundu9@gmail.com

The Word micronutrient represent some essential nutrients that are required in very small amount, micronutrient molybdenum is one among eight micronutrient for growth of plant and microorganism which is needed by plants in a small amount ranged from 12 to 32 g ha-1 for physiological function. In-plant tissues generally it ranges between 0.3-1.5ppm. Molybdenum is present in numerous enzymes. One of these important enzymes is nitrogenase, which fixes nitrogen of the atmosphere and transformed into compounds that allow bacteria, plants, to synthesize and utilize proteins. Molybdenum predominantly found to be an integral part of an organic pterin complex which is known as molybdenum cofactor (Moco). This Moco binds with molybdenum-requiring enzymes (molybdoenzymes) found in most biological systems, including plants, animals and microorganism.

Molybdenum Status among Indian Soils

Among Indian soils total Mo content ranged between 0.4 and 14.5 mg kg^{-1} soil. In Indian soils available Mo contents extracted with ammonium oxalate (pH 3.3), ranged between 0.07 and 2.67 mg kg^{-1}. The availability of Mo in soils depends upon the nature of the parent material and environmental conditions. Deficiency of Mo is not very common in Indian soils. It has been reported that soil of Andhra Pradesh is about 49%, Gujarat 10%, Haryana 28%, Madhya Pradesh 18% are deficient in Mo. On an average 11% of Indian soils are deficient in available Mo. Deficiency of Mo is widely reported in red and lateritic alfisols of the north and north-eastern Himalayan regions, the Konkan and Malabar regions and acidic and leached areas of humid zones. Its deficiency is rarely reported in calcareous alkaline soils of arid and semi-arid regions as these soils have high available Mo contents. Continuous submergence, use of organic manure, high soil pH and use of P and S fertilizers

Volume 2 – Issue 5
Online ISSN: 2582-368X
www.agriallis.com

increased the availability of Mo. As the soil solution becomes more alkaline MoO^-_4 availability increases. Every unit increase above pH 3, MoO^-_4 solubility increases 100-fold primarily through decreased adsorption of metal oxides.

Functions of Molybdenum in Plants, Animals and Human

Molybdenum is involved in several enzyme systems including nitrate reductase, xanthine oxidase, sulfite oxidase etc. As a cofactor for these enzymes, it performs the following functions:

1. Molybdenum plays an important role in N metabolism. It catalyzes the fixation of dinitrogen gas to ammonia by rhizobia in legumes which can be utilized by the host plant.
2. Xanthine oxidase breaks down nucleotides particularly adenine into uric acid which act as an antioxidant. Mo aids in catalyzing the oxidation or metabolism of sulfur-containing amino acids, purines, pyrimidines, and aldehydes.
3. Sulfite oxidase is a Mo-containing hemoprotein and mediates the electron transfer between sulfite and sulfate. This reaction allows our body to metabolize methionine and cysteine (the sulfur-containing amino acids). When these amino acids are not metabolized sulfite will build-up, this can be toxic for the body. Sulfite oxidase turns the sulfite into sulfate, which can be safely removed from the body. Aldehyde oxidase helps in breaking several different types of toxin, including several drugs.
4. The human body contains about 0.07 mg of molybdenum per kilogram of body weight, with higher concentrations in the liver and kidney.
5. Molybdenum present within human tooth enamel prevents its decay.
6. Molybdenum helps in energy production by breaking down some of the amino acids, cell protection, by activating antioxidants, waste removal and by metabolizing toxins that can be excreted in the urine.

Deficiency Symptoms of Molybdenum

1. Mo deficiency in forages grasses (Maize, Sorghum, Pearl millet and Oat etc.) resulted in the golden yellow coloration of older leaves along the apex and the apical leaf margins. Plants had short internodes and reduced foliage.

Volume 2 – Issue 5
Online ISSN: 2582-368X
www.agriallis.com

2. In lambs molybdenum deficiency observed as renal lithiasis which is known as "Xanthine disease".
3. In adult goats, and kids, Mo deficiency decrease feed consumption and cause a reduction in live-weight gains. Reproductive effects of deficiency include decreased pregnancy rates and higher mortality in offspring.
4. On chicken farms, birds displayed a number of symptoms characterized by the loss of feathers, disorders in the ossification of long bones, and changes in joint cartilage, leading to complete immobility.
5. 'Acquired molybdenum deficiency syndrome' in humans characterized by high blood methionine, low blood uric acid, and low urinary uric acid and sulfate concentrations. The patient suffered mental disturbances that progressed to a coma. People severely deficient in molybdenum have poorly functioning sulfite oxidase and are prone to toxic reactions to sulfites in foods.

Factors Affecting Availability of Molybdenum to Plants

1. ***Soil pH***: Soil pH is one of the most important factors affecting the availability of Mo to plants. The MoO_4^{2-} concentration increases 100-fold for each unit increase in pH. With increasing pH, the amount of soluble MoO_4^{2-} in equilibrium with soil Mo which is much greater than $HMoO_4^-$ and H_2MoO_4. Like PO_4^{2-} and SO_4^{2-} , the MoO_4^{2-} anion is strongly adsorbed by Fe and Al oxides at low pH. As a result, Mo deficiency is normally a problem on acid soils.
2. ***Soil texture***: In sandy and low organic matter soil, MoO_4^{2-}retention is low leads to increase in the probability of Mo deficiency; especially with high Mo requiring crops i.e. crucifers and legumes.
3. ***Organic matter***: The amount of ammonium-oxalate-extractable Mo is correlated significantly with organic matter content. Mo complexed with the organic matter may be unavailable to plants in the short term, but it will be released later for plant use through the mineralization process.
4. ***Drainage***: Soil wetness seems to be one of the main factors affecting the availability of Mo. Wet soils tend to have high organic matter content and large amounts of Mo that may be readily available. Poorly drained soils accumulate so much MoO_4^{2-}that the plants grown on them are toxic to animals.

Volume 2 – Issue 5
Online ISSN: 2582-368X
www.agriallis.com

5. ***Nutrient interactions***: Uptake of Mo by plants is usually enhanced by soluble P through the formation of a complex phosphomolybdate anion, which is absorbed more readily by the plants and decreased by available S primarily during the absorption process with an antagonistic mechanism involved during translocation from roots to leaves. Copper-molybdenum antagonism is well known, and toxicity arising from excess Mo in herbage is effectively prevented by applying Cu to the soil. Soils high in Fe_2O_3 are frequently deficient in Mo.

Molybdenum Deficiency Can be Corrected as Follows

1. ***Seed treatment***: Seed treatment is a process where the seeds are soaked in the molybdenum solution, which is an effective approach to prevent Mo deficiency. However, the Mo concentration and content of the seed affect the response. The solution of molybdenum salts is applied on seeds at a rate equal to 50 to 100 g Mo ha^{-1}. When the seed contains Mo in the range 0.5 to 0.7 mg Mo kg^{-1} there will be no response for seed treatment.
2. ***Soil application***: Soil application is an approach where Mo is applied to the soil in the form of fertilizer. The application rate can vary from 100 to 500 grams per hectare depending upon the Mo availability in the soil.
3. ***Foliar spray***: Since plants require such low levels of molybdenum and molybdenum is highly phloem-mobile, a suitable and effective procedure is a foliar application with concentration of 0.1% to 0.5% to correct molybdenum deficiency.
4. ***By liming***: Liming help in reclamation of acidic soil through rising pH of the soil thereby increasing the availability of molybdenum.

Molybdenum Toxicity and Interrelationships between Molybdenum-Copper-Sulphur in Animals;

In forage, Mo concentrations vary and depend on the moisture content, the pH of the soil and concentration in soil. Alkaline environments greatly increase the bioavailability of Mo to plants and thus increase Mo toxicity in grazing animals. Molybdenum is not toxic itself, but when combines with sulfur (S) forms thiomolybdate, which can cause physiological copper (Cu) deficiency in ruminants. There is a risk of secondary Cu deficiency or molybdenosis if the Cu: Mo ratio is less than two. This disorder is referred to as “molybdenosis” or “teart” or “peat scours.” occasionally results in death. Severe

Volume 2 – Issue 5
Online ISSN: 2582-368X
www.agriallis.com

molybdenosis in cattle occurs under natural grazing conditions in many countries. An amount of 20-100 ppm Mo in the herbage on a dry matter basis was related to scouring of cattle and sheep. All cattle are susceptible to molybdenosis, milking cows and young stock suffering the most, with sheep next in susceptibility, whereas horses and pigs are the most tolerant farm livestock. Common symptoms include faded hair coats and profuse diarrhoea with foul-smelling faeces.

Method of Treating Molybdenum Poisoning

If molybdenum poisoning is present, then increasing the intake of copper can prevent molybdenum from binding to the intestine and thus prevent its toxicity in the body. However, copper is a poison so when we are going to feed copper to animals, we have to calculate how much copper has to feed. Too much copper will cause copper poisoning. If the risk of toxicity of Mo does not reduce, the elimination of molybdenum in milk may cause toxicity in nursing calves. Dietary supplementation with copper sulfate will reduce the bioavailability of molybdenum in the gastrointestinal tract, ultimately reducing absorption and increasing excretion. On feeds containing molybdenum more than 5 mg per kg supplementation with 1% copper sulfate in salt will control the development of the syndrome.

Conclusion

Molybdenum is a micronutrient required in minimal amounts by plants. It is mainly absorbed by plants as MoO_4^{2-}. Molybdenum is present in dozens of enzymes. One of these important enzymes is the nitrogenase enzyme, which allows bacteria and plants to synthesize and use proteins by using nitrogen in the atmosphere. Legume forage plant suffers essentially from a shortage of protein due to the failure of the of NO_3^-reduction under Mo deficiency. The human body has about 0.07 mg of molybdenum per kilogram of body weight help in energy production, breaking down certain amino acids, cell protection by activating antioxidants and helps in the removal of waste by metabolizing toxins that can be excreted in the urine. Under molybdenum deficiency, all these metabolic functions will be hindered, so it is very necessary to supply molybdenum externally under deficiency conditions. At the same time, it is also necessary to take care of molybdenum toxicity, as it can cause copper deficiency leads to "molybdenosis "Or" diarrhea "or" peat scores ". All cattle are susceptible to molybdenosis with milking cows and young animals suffer the most, the next sheep in the susceptible while horses and pigs are the most tolerant agricultural livestock. Feed containing

Volume 2 – Issue 5
Online ISSN: 2582-368X
www.agriallis.com

molybdenum more than 5 mg per kg, supplemented with 1% copper sulfate in salt, will control the development of the syndrome. Therefore; molybdenum is highly essential for plants, animals and humans, it should be recommended carefully.

References

Allaway, W.H. (1977). Perpectives on Mo in soils and plants. In: Molybdenum in the Environment (Eds Chappell W.R. and Petersen K.K.), Marcel Dekker, New York, 2:317-339.

Gupta U.C and Lipsett, J.(1981). Molybdenum in soils, plants and animals. *Advances Agronomy* 34:73-115.

Prasad R. (2007). Crop Nutrition –Principles & Practices. New vishal publications New Delhi, pp 231-236.

Prasad, R. and Power, J.F. (1997). Soil fertility management for sustainable agriculture. CRC Lewis, Boca R aton, FL, USA, pp 356.