POTASSIUM IN SOIL – PLANT – HUMAN SYSTEM

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Abstract. *Like nitrogen and phosphorus, potassium is major nutrition`s element contributing to large, steady and high quality crops. In combinations, potassium is widely spread both in the earth crust and in living organisms, more in plants, less in animals. Justus von Liebig was first to asses the importance of potassium in plants in the year 1840; Sidney Ringer did the same in animal species in 1888. In the soil potassium takes form which are partialy soluble and less accesible to plants but also forms which are soluble in water and easy for plants to reach to. The relation between these forms depens on the nature of the clay mineral, the clay percentage, the soil pH. Potassium is indinspensible in the life of plants. It has multiple role which is influenced by the interaction between the plant, the soil and the climatic condition, this is why decoding the specific work mechanism is so difficult. In human body, potassium is one of the most important minerals. It is the one of the main electrolytes alongside sodium and chlorine. Potassium is important in the normal development and growing of the muscles and because of his esential in the functioning of the nervous and cardiovascular systems and can be easily eliminated in diuretic therapies, daily potassium intake are neccesary.*

Key words: *potassium, nutrition, soil, plant, human*

INTRODUCTION

Like nitrogen and phosphorus, potassium is major nutrition's element contributing to large, steady and high quality crops. In combinations, potassium is widely spread both in the earth crust and in living organisms, more in plants, less in animals. Justus von Liebig was to first to assess the importance of potassium in plants in the year 1840; Sidney- Ringer did the same in animal species in 1888.

The importance potassium has in large and high quality crops, is emphasized by the existence of the International Potash Institute in Basel, Switzerland, a non-governmental and non-profit organization founded in 1952 with the purpose of promoting practical and scientific methods to improve the quality of the soil by means of fertilizers, mostly potassium .

Crops need potassium and nitrogen in fairly comparable amounts however everyday agriculture stands proof to a lack of balance in the intake of these nutrients to the detriment of the potassium.

The potassium used in fertilizers , especially in the developing countries, is much below the amount of the potassium in the crops. By way of consequence the amount of potassium in the soil diminishes and so does the soil fertility. Furthermore, an unbalance fertilization means poor efficiency of the fertilizers especially in the case of the nitrogen which is likely to volatilize. The negative effects of the unbalance fertilization on the environment

and the soil sustenation will only add to the farmers dwindling income as a result of a limited use of the potential of the culture.

In plant cells, potassium amounts to 100 mM with an important role in their maturation and consequently in the high quality of the crops.

Potassium is a multifunctional and high mobility element with direct and indirect influence on almost all biochemical and biophysiological processes. It catalyzes numerous enzyme reactions. It helps the formation, transport and deposit of the products of photosynthesis in fruits, grains, tuberculi and contributes to their transformation in fibers, proteins, fats, vitamins. When potassium is low in plants, the process of photosynthesis is reduced affecting thus the distribution of the carbohydrates in plants.

Potassium has a major role in the plant metabolism increasing the resistance to pathogens. Plants with low level of potassium but a nitrogen supplement have soft tissues and are rich in substances with low molecular weight in the cells which is not the case of well fertilized plants. Soft tissues represent inefficient mechanical barriers to the pathogen attack and the lot of cells with low molecular weight , such as sugars, represent food for parasites.

Early change of colors or withering of the leaves, sings of potassium deficiency , attract pests, mostly aphides. It is common knowledge that a balanced fertilization with potassium protects crops from pests.

In animals, potassium is one of the most important minerals. It is one of the main electrolytes alongside Na^+ and Cl^- . Potassium is a positive cation present in cells in 98% from 120 g of potassium in the body. The blood serum contains 4-5 mg K /100 ml and the red cells have 420 mg, the latter being the main indicatory of the potassium intake in the body .

Alongside sodium, potassium regulates the hydric level of the tissues. Potassium has a more facile access into the body of the cell than sodium and activates K – Na exchange through cell membrane. In the nerve cells the K – Na flow generates an electrical potential which stimulates the nervous impulse. When outside the cell , potassium modifies the potential of the membrane and allows the nervous impulse to move forward. This gradient of the electrical potential generated by the Na – K pump stimulates the muscle contractions and regulates the heart beats.

Potassium plays an important role in the biochemical reactions in the cells as well as in their metabolism. It takes part in the protein synthesis from the aminoacids in the cells and in the metabolism of the carbohydrates with an active contribution to the metabolism of the glicogen and the glucose.

Potassium is important in the normal development and growing of the muscles and because of his essential in the functioning of the nervous and cardiovascular systems and can be easily eliminated in diuretic therapies, daily potassium intake are necessary.

DISCUSSIONS

Soil potassium

In the soil potassium takes form which are partly soluble and less accessible to plants but also forms which are soluble in water and easy for plants to reach to. The relation between these forms depends on the nature of the clay mineral, the clay percentage , the pH.

The dynamics of potassium and, related to this, the potassium reserve supply accessible to plant in the soil depends on the inflow of the nutrients in the system formed by the clay mineral , the composition of the soil and the plant roots. To supply plants with

potassium it is crucial for the K ion to move from the surface of the clay minerals into the soil and thus become directly accessible to plants. The chemical desintegration of minerals results in potassium ions which exists in various forms with different degrees of accessibility . They are: the potassium soluble in water, the exchangeable potassium, the unchangeable potassium and the potassium in the mineral network. The first three categories are balanced and irrespective of the potassium supply reserve in the soil there will always be a certain amount of potassium in the solution. The use of fertilizer with potassium soluble in water contributes to a rise of its concentration in the soil solution which leads to its absorbtion into exchangeable and unchangeable forms. The potassium absorbtion by plants contributes to the diminishing of its concentration in the soil solution and the potassium is thus released from the absorbed stages.

Native potassium is a constituent part in the network of primary and secondary minerals and represents the largest amount of potassium in the soil. Primary minerals are an insignificant source of immediate supply with potassium.

Fixed potassium is the potassium form absorbed in the spaces between two packets of aluminiumsilicates which make the crystaline network of the clay minerals in the zeolite and permutite pores. Fixation takes place by alternative moistening and drying of the soil and the packages of aluminiumsilicates that the clay is made of , distance from one another or move close and the potassium ions fill in this spaces with the water molecules satisfying the free negative valences resulting from the isomorphic substitutions. A stronger fixation of the potassium becomes possible if the isomorphic substitution takes place in the leaflet of aluminium octahedrons where the Al^{3+} ion is replaced by Mg^{2+} divalence ions.

Exchangeable potassium represents an important supply potential reserve in plants which have this ion as well as a transition form from exchangeable potassium to potassium in crystaline network. Exchangeable potassium is the potassium retained in ionic form by the negative charges of the absorbent complex and which can be easily moved with weak saline solutions. On balance this is about the potassium ions absorbed in the soil colloids representing less than 1% of the total amount of potassium in the mineral soils. Exchangeable potassium is important for plants it can easily move in the solution to replace other cations. This potassium can be absorbed by the radicular piles by replacing the hydrogen ions which are always present in absorbed form at the surface of the root.

Soluble potassium is the most accessible form to plants. It is the potassium present in the soluble salts of the soil solution as well as that which exists in solution in ionizing form in balance with the ions absorbed by the colloidal complex.

The forms of the potassium in the soil are in balance. A change of concentration of one of this forms entails a reversible compensation movement of all of this forms of potassium until a non-equilibrium forms. The speed of movement of the equilibrium depends of the degree of concentration change in one of the stages of the system, on the abundance of the potassium rich minerals, on their crystaline structure, the degree of alteration , the humidity of the soil , the pH, the amount of clay, the capacity of the soil to keep the potassium away.

The balance between the potassium free from the soil solution and the exchangeable potassium bears relevance when the supply state of the vegetation time is analyzed and the relation between exchangeable and unchangeable potassium illustrates the potential state of supply over a longer period of time.

Plant potassium

Potassium is indispensable in the life of plants. It has a multiple role which is influenced by the interaction between the plant, the soil and the climatic conditions , this is why decoding the specific work mechanism is so difficult.

Generally speaking potassium exists in larger amounts in the tissues with higher biological activity where it is located mostly inside the cells. The ratio of the levels of potassium inside the cell and potassium outside the cell is 25:1. In plants potassium exists almost exclusively as ions and this increases its osmotic capacity. The average amount of potassium in plants is 10 mg/g. Potassium is a cation present in a number of organic substances which are synthesized or which accumulate in plants. The growing tissues are richer in potassium. In the bodies where aminoacids and soluble glucides form there is a larger amount of potassium.

Potassium has an significant role in the biosynthesis, transport and deposit of glucides, especially oligoglucides and reserve poliglucides (starch) as well as in regulating the osmotic pressure or opening the stomates and also in the water circulation in the plant tissues. It is a catalytic agent and an activator of over 46 enzymatic systems keeping the ionic environment at levels favorable to the activity of the enzymes.

Potassium is one of the main elements which reduce perspiration, makes plants more resistent to frost and drought, to diseases and pests. It improves the quality of the yield and increases the storage time of the crops. It influences in the positive way the formation of the clorophyle. It ensures the colloidal state of the protoplasm as well as its hydration. It stimulates photosynthesis and the biosynthesis of the proteic substances , the respiration and phosphorilation reactions.

Potassium has a multiple and complex role in the normal functioning of the cells, in regulating the permeability of the citoplasmatic membrane, in the metabolism of the nitrogen.

It has been demonstrated that the absence of potassium increases the activity of amylase, saccharase, glucosidase, galactosidase, pectinase and proteasis. Deficiency of this element causes a disturbance in the metabolism of proteines allowing free aminoacids and amids to accumulate in the plant. Potassium deficiency leads to poor turgescence of the plant which thus appears to wither. On old leaves there are cloroses and necroses. Unlike the necroses caused by absence of magnesium (which they resamble) necroses caused by potassium deficiency appear at the extreme parts of the limbus which turn brown and withe. Such symptoms are first manifested in old leaves. In early stages absence of potassium leads to the writhing of the plants associated with a serious shortening of the internodes and eventual fall of the plant.

The potassium amount in the leaves of plants with potassium deficiency is often below 10 mg/g d.m., whereas in well supplied plants it ranges between 15 and 50 mg/g d.m.

The main characteristic of the potassium deficiency in plants are the necroses which start at the end of the leaves and advance towards the central vein, from tip to the larger end.

Potassium in human body

Potassium has numerous functions in the human body: it ensures an appropriate environment in the cell. The sodium-potassium pump plays an active role in facilitating the access of various substances into the cell through the membrane.

Potassium has a role in the formation of proteins and the cell constituents; the potassium ions are "key" activators of the enzymes in the metabolism of carbohydrates,

proteins and fat acids.; K^+ and Na^+ in an ATP environment make up an active transport system in a series of process: the transmission of the nervous influx, the muscle activity of the brain, the heart activity and that of the internal secretion glands; it also balances the acid/base activity, that of the H^+, K^+, Na^+, Ca^{2+}, Mg^{2+} ions as well as the hydric presence; it takes part in the transport of the oxygen and the carbon dioxide in the blood; it influences the absorbtion of the aminoacids in the cell being thus involved in the metabolism of proteides, lipides and glucides; having a high ionisation capacity, the potassium ion settles in the muscular fibres in the process of protein formation ; it prevents muscular fatigue, increases neuro-muscular excitability (with effects antagonistical to those of calcium); it is important in maintaining the cardiac automatism - lab experiments with animals have revealed that in cases of hipopotassium heart attacks take place in the systole whereas in cases of hyperpotassium they are in the diastole; it takes part in the digestion where it is present in the pancreatic and intestinal juice; it has diuretic effects caused by the physiochemical action on the glicoproteic complexes of the tissues facilitating the elimination of water and sodium chloride.

For an normal metabolism an adult needs 2-4 g K/day. Potassium deficiency may cause an unbalance the electrolytes which are responsible for the intercellular equilibrium directly related to the metabolism of the cell. Other effects of potassium deficiency are slow growing (connected to the proteine metabolism), muscular fatigue, cramps, paralysis, low apetite, increase of intercellular acidity, dgeneration of vital organs, neuromuscular, heart and nerve disfunction. The sky also dehydrates.

In animals, potassium is present as soluble Cl^- and HCO^-_3. As a rule, mineral elements are easily absorbed as chlorides, carbonates and acids. Potassium plays a number of roles here: when ionized it exists inside, outside and between cells, in concentrations which are below 1%, and maintains the necessary osmotic pressure characteristic of the three environments; once its concentration rises, the neuromuscular excitability increases; potassium activates numerous enzyme systems trough the hormone regulating mechanisms. Potassium, alongside magnesium, is a mitocondrial intercellular catalyst.

Little is known about the need for potassium in various animal species because potassium deficiency is rarely seen in practice.

CONCLUSIONS

Potassium is a major constituent in all living cells and, potassium (K) is essential nutrient required in large amounts by plants, animals and humans (Hamdallah, 2004). Most potassium occurs in the earth's crust as mineral, such as feldspars and clays.

Potassium ranks seventh in order of abundance in the earth's crust. As rocks slowly disintegrate, potassium is released, but the rate of release is too slow to provide the large amounts of this essential nutrient required by crops. Humans obtain the majority of their potassium either directly from plants or indirectly through the animal products in their diet. Potassium is a key element for crops / plant growth. Therefore, the intricate relationship between plant nutrition, animal nutrition and the impact on food chain for human is very much essential.

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