Potassium – Transformation, factors affecting Potassium availability, deficiency and toxicity symptoms

Learning objectives

- a. To understand the transformation of Potassium
- b. To study the forms of K and factors affecting K availability
- c. To understand the deficiency symptoms of Potassium

Potassium

The potassium ion (K^+) is actively taken up soil solution by plant roots. The concentration of K^+ in vegetative tissue ranges from 1 to 4% on dry matter basis.

Functions of potassium

- 1. Essential for photosynthesis, development of chlorophyll.
- 2. It improves vigour of the plants to enable to with stand adverse climatic conditions.
- 3. Reduces lodging in cereal crops.
- 4. It regulates stomata opening and closing.
- 5. It regulates the movement of ions with in the plants and hence it is called **traffic policeman** of the plant.
- 6. Activation of enzymes, enzyme synthesis, peptide bonds synthesis.
- 7. Regulates H_2O imbalance within the plant.

Sources of K

The micas and fieldspars constitute the major K bearing minerals which on weathering slowly release K to the soil.

(Muscovite and biotite) (Orthoclase and microcline)



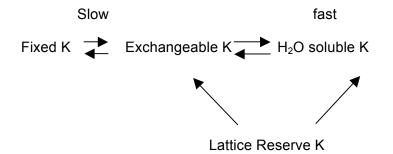
K-Feldspar: KAISi₃O₁₀.

Courtesy: http://ocw.mit.edu/ans7870/12/12.108/f04/imagegallery/lab3/lab3-32.html

Forms of potassium in soils

- a. Water soluble K.
- b. Exchangeable K.
- c. Fixed or Non exchangeable K.
- d. Lattice or Mineral K.

The different forms are in dynamic equilibrium with one another and represented as follows.



Water soluble K

The Concentration of H_2O soluble K in soil depends on (a) type of day (b) H_2O content (c) Intensity of leaching (d) Amount of exchange K (e) Kind and concentration of other ions.

The dilution of the soil, increases the concentration of H_2O soluble K and drying decreases it. The uptake of K is influenced by the presence of other cations, ie Ca²⁺ and Mg²⁺, Al³⁺ (acidic soils) and Na⁺ in salt affected soils.

2. Exchangeable K

The K adsorbed on soil clay complex and replaceable with neutral salts in relatively short time. The CI reacts with soil Ca and form Ca Cl_2 which is leached by high rainfall. Hence **K is called** as **Decalcifier**

3. Non exchangeable or Fixed K

Added K which is firmly bound by the soil and not immediately replaceable with neutral salts.

4. Lattice K or Mineral K

Muscovite, biotite and K feldspar. The capacity of soils to release lattice K by weathering depends on the content of K minerals and soil texture.

Potassium fixation

The important of K fixation is to regulate the supply of the soil a for the plants and protects it against loss through leaching.

In the dynamics of soil Potassium, the phenomenon of fixation of exchange K and the liberation of non-exchange K play an important role. K ions are relatively small to enter the silica sheets where they are held firmly by **electrostatic forces**. The presence of K^+ ions can block the release of fixed NH_4^+ and vice visa.

Factors affecting K fixation.

- 1. Soil texture : Increases the texture grater will be fixation and vice visa.
- 2. Wetting and drying: Fixation is more under dry condition than wet condition.
- 3. Type of day min: Fixation is more in 2:1 type than 1: 1 type
- **4. Freezing and thawing :** Enhances the fixation of K depends their clay mineralogy and degree of weathering
- **5.** Soil pH : A decreases in pH reduces the K fixation either as result of competition of H₃O⁺ for the inter layer exchange position. Liming also favors for the fixation of K.

Factors affecting K availability in plants

a. *Kind of clay minerals*: Soils containing vermiculite or montmorilonite will have more K than kaolinite clay soils.

b. *Cation exchange capacity*: Increases texture soils having higher CEC and can hold more exchange K.

c. Amount of exchangeable K: More K in soil solution leads to

Higher fixation.

d. *Subsoil K and rooting depth*: Low soil temperature may exhibit K release and diffusion, thus increasing crop response to K

e.Soil moisture: fertilization increasing K levels or moisture contain will accelerate K diffusion.

- **6. Soil temperature :** The reduced temperature slow down plant process plant growth and rate of K uptake.
- **7.** Soil aeration : Under high moisture levels or incompact soils root growth is restricted, O₂ supply is lowered and absorptions of K is slowed.
- **8.** Soil pH : In very acid soils, toxic amount of exchange Al³⁺ and Mn²⁺ create unfavorable root environment for uptake of K and other nutrients.
- **9.** Ca and Mg : K uptake would be reduced as Ca²⁺ and Mg²⁺ are increased or uptake of these two cations would be reduced as the available supply of K is increased.

10.Tillage: Tillage is increased that K availability is reduced because of increases compaction, less aeration and lower temperature.

Plant factors affecting K availability

1. CEC of Roots :Important for determining the ability of plants to absorb like more slowly available forms of soil K.

2. Root system and crop :Higher root density, higher the removal of exchange K and soil solutionK. Fibrous root system absorbs more K than tap root system.

- 3. Variety or Hybrid :Hybrid absorbs more K than variety.
- 4. Plant population :Higher plant population and closer spacing increased the K removal.

Deficiency symptoms

- 1. Plant becomes stunted in growth with shortening of internodes and busy in appearance.
- 2. K deficiency in plants show reduced rate of photosynthesis.
- 3. Chlorosis, yellowing of leafs and leaf scarch in case of fruits trees.

Rice : The leave tips will dark brown in colour and blades will blueish green, chlorotic and necrotic are seen.

Banana : Deficiency is seen in the margin and bottom of leaves.

Grapes : Leaves are yellow with brown spots which are necrotic, brittle with uneven ripening.

References

Tisdale,S.L.,Nelson,W.L.,Beaton,J.D.,Havlin,J.L.1997.Soil fertility and Fertilizers.Fifth edition, Prentice hall of India Pvt.Ltd,New Delhi.

Singh, S.S.1995.Soil fertility and Nutrient Management. Kalyani Publishers,Ludhiana.

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Questions to ponder

- 1) What is luxury consumption?
- 2) What is activity ratio and what does it measure?
- 3) How does CEC affect the amount of K in solution?
- 4) What is the effect of K: Ca ratio in K availabity?
- 5) Does fixed K tend to become available to plants?