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

Learning objectives

- To understand the transformation of Potassium
- To study the forms of K and factors affecting K availability
- 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

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

Sources of K

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

(Muscovite and biotite)

(Orthoclase and microcline)



K-Feldspar: $KAlSi_3O_{10}$.

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

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 H_3O^+ 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, O_2 supply is lowered and absorptions of K is slowed.
 8. **Soil pH** : In very acid soils, toxic amount of exchange Al^{3+} and Mn^{2+} create unfavorable root environment for uptake of K and other nutrients.
 9. **Ca and Mg** : K uptake would be reduced as Ca^{2+} and Mg^{2+} 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 solution K. 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 bushy in appearance.
2. K deficiency in plants show reduced rate of photosynthesis.
3. Chlorosis, yellowing of leaves and leaf scorch in case of fruit trees.

Rice : The leaf tips will turn dark brown in colour and blades will be 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

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

<http://ocw.mit.edu>

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 availability?
- 5) Does fixed K tend to become available to plants?