# اسمدة متقدم 7

# Mineralization of organic phosphorus in soils

organic P → inorganic P ( mineralization )

inorganic P → organic P ( immobilization)

c/p < 200:1 mineralization

c/p > 300:1 immobilization

The mineralization of organic P has been studied in relation to the ratio of C: N : P in the soil. A C:N:P ratio of 100:10:1 for soil organic matter has been suggested , but values ranging from 229:10: 0.39 to 71: 10:3.05 have been found.

* Factors affected P mineralization

- temp.

temp. ↑ → mineralization ↑

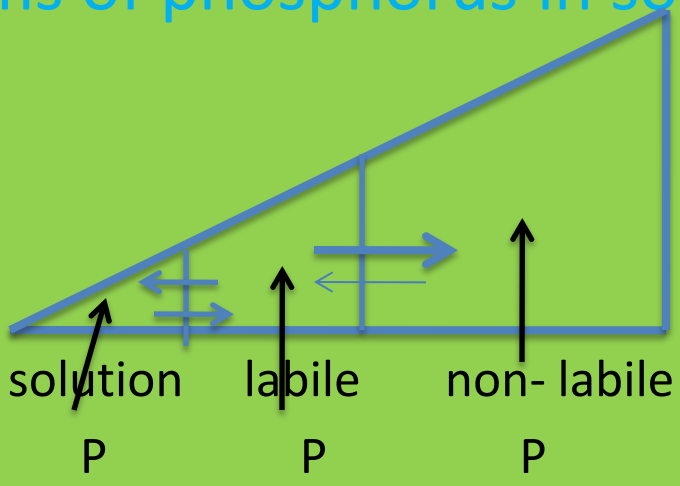
- PH

pH ↑ → mineralization ↑

- pH increase microorganisms activity
- reduce O.M. adsorption on clay particles

- any factor affect microbes activity in soil affect p mineralization .

# Inorganic forms of phosphorus in soil




1- solution p : i- inorganic forms depending on pH

$H_3PO_4$ , $H_2PO_4^-$ , $HPO_4^{-2}$ , and $PO_4^{-3}$

absorbed forms : $H_2PO_4$ and $HPO_4$ ( $H_2PO_4$ is favorable form) as soil pH increase

$$H_3PO_4 \longrightarrow H_2PO_4 \longrightarrow HPO_4 \longrightarrow PO_4$$

at pH 5-7 $H_2PO_4$ is dominate

at pH 7-9 $HPO_4$ is dominate

on assumption that no ions such as Fe, Al, Ca, and Mg are present. when they are , the insoluble phosphate of iron , aluminum will be precipitated in acid soil and the insoluble phosphate of calcium and magnesium at pH greater than 7.0 . A series of phosphorus compounds of varying solubilities is formed under different soil conditions. As a general rule of thumb, max. availability of P to most agricultural crops occurs with in the soil pH range of 5.5 to 7.0.

pH of cultivated is usually between 4.5 – 8 so, dominate forms of phosphorus are $H_2 PO_4$ and $HPO_4$ .

ii- soluble organic P

- low quantity as compared with inorganic forms
- do not affected by soil pH
- soil texture plays major role

sandy > sandy loam > silt loam

iii- ions pair

$CaH_2\ PO_4$ and $MgH_2\ PO_4$

forms cannot absorbed by plants

2- Labile forms

- phosphorus absorbed on surfaces or at beginning of reactions with Ca, Mg , Fe, or Al
- non- specific reactions
- in equilibrium with soluble form
- change with time to non-liable form

3- non-labile forms

- more than 90% of total P in soil
- non available forms to plants
- usually in apatite forms in alkaline soil and in versicite and stringite forms in acid soils
- in slow equilibrium with labile forms

## Reaction of Phosphate in Alkaline soils

* precipitation as Dicalcium phosphate

- in most alkaline soils the activity of the calcium is high . This , coupled with a high pH, favors the precipitation of the relatively insoluble dicalcium phosphate and other basic calcium phosphates such as basic calcium phosphate such as hydroxy-apatite and carbonapatite.

* Surface precipitation on solid phase $CaCO_3$

P ions coming in contact with solid phase $CaCO_3$ are precipitated on surface of these particles . The amount of precipitation is influenced by the amount of surface exposed by $CaCO_3$ and P conc. in solution. Initial stage of this process is considered to be surface phenomenon. Subsequent deposition may be of the mass action type, the rate of precipitation being governed by the conc. of the reactants in the soil solution. End products seems to be a relatively insoluble salts of Ca , P, and perhaps $CO_3^{-2}$ or $OH^{-1}$ .

* Retention of P by clay saturated with Ca

A linkage such as clay – Ca- $H_2PO_4$ has been suggested. Such reactions might occur at pH value slightly less than 6.5 , but in soils more basic than this dicalcium phosphate would probably precipitated from solution.

## Factors influencing phosphorus retention in soils

- Type of clay

1: 1 greater than 2:1 and presence of hydrous oxides of Fe and Al also contributed to P fixation of added P.

- Time of reaction

the greater the time the soil and added P are in contact , the greater the amount of fixation . ( find the practical consequence of this ).

- Soil reaction

in most soils P availability is at max. in pH range 5.5-7.0 , availability decreased as pH devoid from this range .

- Temp.

the soils with of the warmer climates are generally much greater fixer of P than the soils of more temperate regions. These warmer climates also give rise to soils with higher contents of the hydrous oxides of Fe and Al.

- organic matter

add organic matter increase the availability of soil and added P . (Find mechanisms involve in this effect )

# Soil factors influencing phosphorus availability

The amount of P uptake by plant roots is usually in direct proportion to root conc. P . However, the specific quantity of P contained in the root surface area is practically negligible($<5\%$) . Therefore, the root hairs must grow to the P source, or the fertilizer P must move to the root surfaces at rate adequate for plant growth. Phosphorus moves in soil through:

a- mass flow  b- diffusion ( plays major role in P movement)

Depends on

i- intensity factor ( conc. of P in solution)

ii- capacity factor ( quantity of P that will be released by the soil as the intensity lower around the roots)

i + ii = soil buffering capacity

iii- diffusion coefficient ( varies with water content of soils )

- Chemical characteristics

- form of soil phosphorus

organic vs inorganic

- soil PH

effect on p- forms

- P levels in soil

↑ in soil → ↓ response to fertilizer

Physical characteristics

- aeration and compaction

effect form of some ions e.g $Fe^{+2}$ → $Fe^{+3}$ (under anaerobic)

↓

more mobile in soil

- temp. and moisture

positive correlation

- movement and losses

p immobile in soils

| Common names (formulae) | | Grade or analysis in percent | | | | |
|---|---|---|---|---|---|---|
| | | N | $P_2O_5$ | $K_2O$ | Mg | S |
| **Nitrogen fertilizers** | | | | | | |
| Ammonium sulphate $(NH_4)_2SO_4$ | | 21 | 0 | 0 | - | 23 |
| Ammonium nitrate $NH_4SO_3$ | | 33-34.5 | 0 | 0 | - | - |
| Ammonium nitrate-limestone $NH_4NO_3+CaCO_3$ (calcium ammonium nitrate) | | 20.5-26 | 0 | 0 | - | - |
| Urea $CO(NH_2)_2$ | | 45-46 | 0 | 0 | - | - |
| Ammonium sulphate-nitrate $NH_4NO_3 \cdot (NH_4)_2SO_4$ | | 26 | 0 | 0 | - | 15 |
| **Phosphate fertilizers** | | | | | | |
| Single superphosphate $Ca(H_2PO_4)_2 + CaSO_4$ | | 0 | 16-20 | 0 | - | 12 |
| Triple or concentrated superphosphate $Ca(H_2PO_4)_2$ | | 0 | 46 | 0 | - | - |
| Ground rock phosphate (mineral phosphate) | | 0 | 20-40 | 0 | - | - |
| **Potash fertilizers** | | | | | | |
| Muriate or chloride of potash KCl | | 0 | 0 | 60 | - | - |
| Sulphate of potash $K_2SO_4$ | | 0 | 0 | 50 | - | 18 |
| Sulphate of potash-magnesia $K_2SO_4 \cdot 2MgSO_4$ | | 0 | 0 | 26-30 | 5-7 | 16-22 |
| **Magnesium fertilizers** | | | | | | |
| Kieserite | $MgSO_4 \cdot 7H_2O$ | - | - | - | 16 | 22 |
| Calcined kieserite | $MgSO_4 \cdot H_2O$ | - | - | - | 20 | 27 |
| **Sulphur fertilizers** | | | | | | |
| All fertilizers containing S as anion | | - | - | - | - | according to formula |
| Gypsum | $CaSO_4 \cdot 2H_2O$ | - | - | - | - | 16-18 |
| **Some fertilizers with regional importance** | | | | | | |
| Sodium nitrate | $NaNO_3$ | 16 | 0 | 0 | - | - |
| Di-calcium phosphate | $Ca(HPO_4)$ | 0 | 35-42 | 0 | - | - |
| Basic slag | | 0 | 16-20 | 0 | 1-3 | - |

# Phosphate Fertilizers Terminology

water- soluble phosphorus : -

A small sample of the material to be analyzed is first extract with water for prescribed period of time. The slurry is then filtered, and the amount of P contained in the filtrate is determined. Expressed as % by weight of the sample , it represents the fraction of the sample that water- soluble.

Citrate- soluble Phosphorus :-

The residue from the leaching process is added to a solution of neutral 1*N* ammonium citrate. It is extracted for a prescribed period of time by shaking, and the suspension is filtered. The P content of the filtrate is determined, and the amount present expressed as% of total weight of the sample, is termed the citrate- soluble phosphorus.

Citrate- insoluble phosphorus :-

The residue remaining from the water and citrate extraction is analyzed. The amount of P found is termed citrate – insoluble.

Available P :- water soluble + citrate soluble

Total p :- the sum of all above. However, it could be determined directly.

# Factors influencing the availability of fertilizers phosphorus

1- Fertilizers material characteristics

2- Soil physical & chemical characteristics

3- application methods

Fertilizers material characteristics including:-

1- chemical material characteristics depends on chemical forms, particles sizes, water solubility, and associated salts.

- chemical forms:- depends on soil properties, plants , application methods.
- particle size & water solubility:- effect of particle size depend on their water solubility.

water insoluble P is more effective when applied in non-granular form.

highly water- soluble carriers min. soil contact is desirable and granular materials are preferable.

- associated salts:-
  - effect of salts on fertilizers reaction in soils.
  - improve plant growth
  - apply $(NH_4)_2 SO_4$ increase P uptake ( find why?)
  - ↑ uptake ⟶ ↓ zn uptake ( find reasons for that)

## 2- soil physical & chemical chartreistics

- soil texture : it effects through diffusion rate, rate of chemical Rx., and the reaction of products .
- soil moisture : at opt. level ↑ availability of all p sources.
- soil temp. : depends on fertilizers type . ↑ temp. ↑ O. P. availability .
- soil pH and $CaCO_3$ : have been discussed previously.

## 3- application methods

methods of application: i- broad casting ii- banding iii- seed placement. Which method is better depends on soil properties and fertilizers type, as soil fixing capacity increase the contact between soil and fertilizers particles should decrease.

## Biological fertilization of P

importance of Mycorrhizal , phosphate dissolving fungi and phosphate dissolving bacteria.