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NUTRIENT INDEXING OF OLSEN'S PHOSPHOROUS WITH RELATIONSHIP BETWEEN INORGANIC FORMS OF PHOSPHOROUS IN THE ALLUVIAL SOILS

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Abstract– The phosphorous nutrient index value estimated in the soils along the Yamuna River in Prayagraj falls into the low to medium fertility class. The inorganic forms of phosphorous, namely aluminium bound phosphorous (Al-P), represented 2.15 percent of total-P, resulting in a relatively low proportion, while calcium bound phosphorous (Ca-P), comprised 31.57 percent of total-P. The correlation coefficient (r) between Olsen P and forms of phosphorous saloid P (S-P) was extremely high among all (r = 0.979*) and occluded bound-P (Occl-P) was significantly associated among the inorganic forms (r = 0.767*). This suggests that Occl-P has a significant contribution to the available phosphorous, it is said to be that from the forms of phosphorous Saloid P and Organic P values should be raised and it is recommended that soils with low content of phosphorous are advised to apply organic manures and supplemented by applying of phosphorous fertilizers in the specified crop to increase the levels of P in the soil.

INTRODUCTION

Plant growth, crop yield, and quality all depends on phosphorus. Farmers frequently use P fertilisers more than plant requirements due to limited soil P availability and low fertiliser usage efficiency. Because the bulk of applied P is swiftly fixed or precipitated into poorly accessible forms, only 10-20 percent of the P applied with fertilisers is taken up by plants in the year after application (Vu *et al.*, 2008). P fertilisers that are applied to the soil react with the soil elements and change into different forms. Many soil elements react with P to convert it to inaccessible forms, and soil conditions have a substantial role in determining the dominance of each fraction. The amount of P fertiliser required is determined not only by the crop's P demand, but also by the crop's soil P requirement the quantity of soil P that can be extracted and the soil's ability to repair P. Most methods currently in use to quantify soil phosphorus (P) were developed for agronomic purposes, that is, with the aim of providing an estimate of the phytoavailable soil P (Maria *et al.*, 2010).

Phosphorus may be found in both inorganic and organic forms in soil. Most agricultural soils include 50-75 percent organic P, while this percentage can range from 10-90 percent (Sharpley and smith, 1985). In acidic, noncalcareous soils, inorganic P forms are connected with hydrous sesquioxide's, amorphous and crystalline Al and Fe compounds, and in alkaline, calcareous soils, with Ca-compounds. Easy soluble phosphate (S-P), aluminium phosphates (Al-P), iron phosphates (Fe-P), reductant soluble phosphates (RS-P), and calcium phosphates (Ca-P) are the several types of inorganic phosphates found in soils (Chang and Jackson, 1957). Al-P, Fe-P, and RS-P are dominated by strong acid soils that are generally severely weathered. All five components are frequently present in equivalent levels in neutral and slightly acid soils. Ca-P is commonly found in alkaline and calcareous soils as P available.

MATERIALS AND METHODS

Twenty-four soil samples were collected along the Yamuna riverbank in Prayagraj, Uttar Pradesh, from six different locations and depths, namely 0-15, 15-30, 30-45, and 45-60, and air dried and sieved 2 mm before being tested for different physio-chemical properties, as all samples had neutral pH 0.5 M. NaHCO3 Olsen's *et al.* (1954) approach employed the extractant to determine the available phosphate. The Chang and Jackson (1957) technique, as modified by Peterson and Corey (1966), was used to fractionate the inorganic phosphorus. As shown in Table 1, Soils were treated with each extractant solution before being put through a series of tests. The aliquot was then stained with chlorous stannous blue colour solution, and the absorbance was measured using a UV spectrophotometer at a wavelength of 660 m. The association between the sample values was determined using Pearson's co-relation (r). Spatial analysis has been performed with the help of QGIS.

The Nutrient Index of the Soil was used to compute the Fertility Status of Phosphorous in the topsoil (0-15 cm) using the nutrient rating chart in Table 2. The nutrient rating chart was used to grade the Phosphorous analytical findings and the criteria to calculate the nutrient index. Ravikumar and Soma Shekar (2013). The nutrient index in soil was calculated using the following method for the soil samples examined

Table 2. Nutrient index (Fertility class) chart of Phosphorous

Fertility Class	Ranges
Low	<1.67
Medium	1.67-2.33
High	>2.33

$$Nutrient\ Index = \frac{(1 \times no.\ of\ samples\ in\ low\ category) + (2 \times no.\ of\ samples\ in\ Medium\ category) + (3 \times no\ of\ samples\ in\ High\ catergory)}{Total\ no.of\ samples}$$

Fig. 1. Estimating the Available and Fractions of Phosphorous using UV Spectrophotometer (left) and estimating the soil pH (right), respectively.

RESULTS AND DISCUSSION

Distribution of Phosphorus Fractions

Saloid P was found in soil at varying concentrations from 2.0 to 3.0 ppm, accounting for 4.13 percent of total P. Al-P level in these soil profiles ranged from 1.61 to 1.83 ppm, contributing for 2.15 percent of total-P. Strong weathering well-drained humid tropics are indicated by very low Total-P content in soils (Sarkar *et al.*, 2014). Fe-P levels in the soils ranged from 5.61 to 7.29 ppm, contributing for 10.44% of total P. Occl-P has a range of 1.54 to 3.89 ppm and makes up 3.98 percent of Total-P. Red-P levels in the soils examined range from 1.6 to 2.1 ppm, contributing for 3.00 percent of total-P. Ca-P levels in soils varied from 15 to 25 ppm, contributing for 31.57 percent of total P. Inorganic-P comprises all P fractions, such as S-P, Al-P, Fe-P, Occl-P, Red-P, and Ca-P, with values ranging from 27 to 44 ppm, whereas organic-P values varied from 25 to 28 ppm.

Table 1. Different methods of soil phosphorus quantification.

Fractions	Extractant solution	Reference
Available P	0.5 M $NaHcO_3$	Olsen's *et al.*, (1954)
Saloid bound-P	1 M NH_4Cl	Chang and Jackson (1957)
Aluminium bound-P	NH_4 OH with pH 8.2	as modified by (Peterson
Iron bound-P	0.1 M NaOH solution, NaCl Solution	and Corey1966)
Reductant soluble-P	0.3 M Sodium citrate solution	
Occluded bound-P	0.1 M NaOH solution	
Ca bound-P	0.25 M H_2 SO_2	
Mineral/ Inorganic-P	Conc HCl	Hesse, (1971)
Total-P	Vanadomolybdate method	
Organic-P	Total-P – Inorganic-P	———

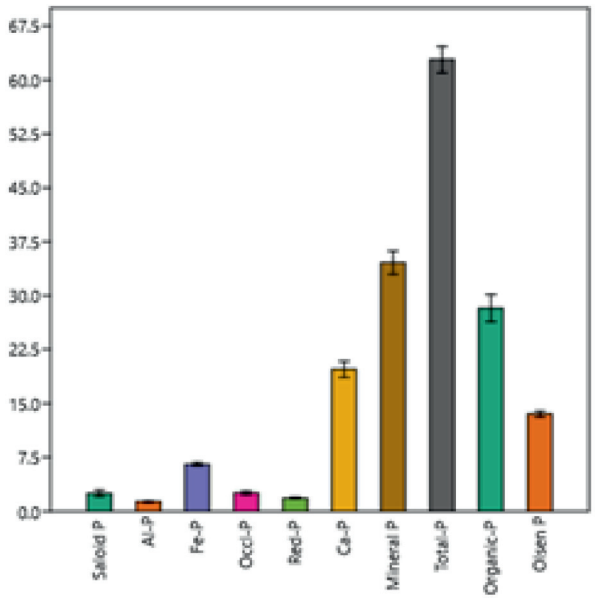

Fig. 2. Graphical representation of Forms of Phosphorous in the Alluvial Soils of Prayagraj

As shown in Figure 2, total P values ranged from 57 to 72 ppm. In all the profiles, there was a significant decrease in P levels from the upper layer to the lower layer.

Co-relation Co-efficient (r) of phosphorous Fractions with Available-P (Olsen-P)

Al-P (r = 0.407*), Fe-P (r = 0.557*), and Occl-P (r =0.767*) were significantly and positively correlated with available-P among the inorganic fractions. This indicates the phosphorous fractions that contribute to the soil's available P pool. Total-P (r = 0.979*) and Organic-P (r = 0.660*) were shown to be positively linked with available P, indicating that increasing their concentrations in the soil increases available P. The available P has indeed been adversely and very weakly linked with saloid P (r = -0.181), Red-P (r = 0.136), and Ca-P (r = 0.239). As a result, these forms of P add relatively little to the pool of available P in the soil. Similar findings were made with (Sharma and Tripathi 1984). (Patiram *et al.,* 1993).

Table 3. Co-relation Co-efficient (r) of phosphorous Fractions with Available-P (Olsen-P)

Fractions	Available P (P_2O_5)
Saloid P	-0.18*
Al-P	0.407*
Fe-P	0.557*
Occl-P	0.767*
Red-P	0.136
Ca-P	0.239
Mineral P	0.336
Total-P	0.979*
Organic-P	0.660*

Fertility Status of Available P (Olsen's P) in the Soils

According to the nutrient index of phosphorous reported by, the quality of available phosphorous in the topsoil in the alluvial soils of Prayagraj along the Yamuna riverbed in the study area is medium to low (Muhr *et al.,* 1965). According to Table 2, the nutrient index of the phosphorous fertility class in the soils of the study area varied from 2 to 3. The standard concentration of medium range phosphorous in soil is 12.4 to 22.4 Kg ha-1, where the range of phosphorous was between 13 and 21 Kg ha-1 (Muhr *et al.,* 1965).

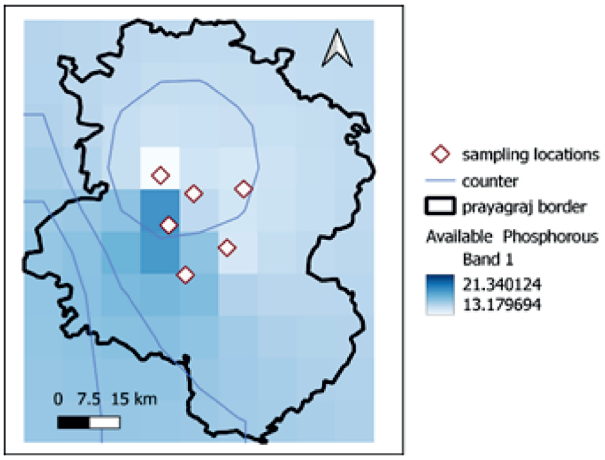

Fig. 3. Spatial distribution of Available Phosphorous in Prayagraj District

CONCLUSION

Based on the criteria of calculating Nutrient Index, in the alluvial soils of Yamuna riverbank of

Table 4. Measured concentration of available phosphorus

S. No	Grade	Concentration (Kg ha^{-1})	Range (No of Samples)
1	Low Phosphorous	Less than 12.4	-
2	Medium Phosphorous	12.4 to 22.4	13-21 (6)
3	Adequate Phosphorous	More than 22.4	-
4	Abundant Phosphorous	Still higher	-

Prayagraj, are characterised from low to medium range class with available Phosphorous, it is said to be that from the forms of phosphorous Saloid P and Organic P values should be raised and it is recommended that soils with low content of phosphorus are advised to apply organic manures and supplemented by applying of phosphorus fertilizers in the specified crop to increase the levels of P in the soil.

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