

## Original Research Article

# **Effect of added phosphorous and organic matter on the availability of phosphorous fractions in normal soil under field capacity moisture tension**

### **Abstract**

An Incubation study was conducted during January 2020 – May 2020 under “Laboratory condition” Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad Kanpur University of Agriculture and Technology, (U.P.) to study the “**Effect of added phosphorous and organic matter on the availability of phosphorous fractions in normal soil under field capacity moisture tension**”. To obtain different fraction of phosphorus under field capacity regime in all three experiments were conducted under kankar soil condition to determine Ca-P, Al-P and Fe-P as influenced by six different treatments. The results showed that with advancement in time of incubation, the availability of Ca-P (308.2 ppm and 235.3 ppm at 0 days and 90 days of incubation period, respectively), Al-P (89.5 ppm and 44.9 ppm at 0 days and 90 days of incubation period, respectively), while Fe-P (13.8 ppm and 13.1 ppm at 0 days and 90 days of incubation period, respectively) increased marginally at field capacity in kankar soil condition. Sunhemp (T<sub>2</sub>) proved more beneficial than FYM (T<sub>3</sub>) in increasing Fe-P, Al-P, and Ca-P as also Olsen’s P content in the soil. Therefore, application of organic matter either in the form of sun hemb with phosphorus proved very useful in improving avoidable content of the soil.

**Key Words: Field capacity, Incubation period, Organic matter and Phosphorous**

### **Introduction**

Phosphorus (P) is essential for plants and animals because of its role in vital life processes, such as in photosynthesis in plants and energy transformations in all forms of available to crops. Thus, unless the soil contains adequate amount of plant-available P or is supplied with readily available-(inorganic)-P fertilizers, crop growth will suffer (**Sanyal and Datta, 1991**). Although P is one of the most important Factors to limit soil ecosystem productivity (**Zhu et al., 2004**). Phosphorus has been called bottle neck of the world's hunger". This is true for large parts of the world, particularly Australia and South Africa where the crop production. Limited over enormous area by phosphate supply, Colling has stated as follows, “Low crops yield are more often due to lack of phosphoric acid than due to

lack of any other nutrients”. Phosphoric acid has often been called ‘Master Key’ to agriculture. Phosphorus has been attributed a role in the further plant growth processes: Carbohydrate breakdown for energy release, Cell division, Transfer of inherited characteristics, Stimulation of early root growth and development Hastening maturity of plant Fruiting and seed production, Energy transformation.

In a statistical study by IARI, with data on more 8 million soil tests, it was found that available phosphorus status of soil of 363 districts of India, comprising about 46.3% districts, that are low in category, 51.5% constitute the medium category and only 2.2% shows high category of P level in soil. Thus, 98% of cultivated soils in India stand in a need of P fertilizers for an efficient production level. The lower halves of the Ganga -Yamuna and Ganga-Gomti doabs right up to Azamgarh districts are the worst affected districts. The salts, found, cause physical deterioration by destroying soil structure and reducing permeability, besides increasing soil pH, and making nutrients unavailable. Saline-Alkali soils are characterized with high pH, appreciable  $\text{CaCO}_3$  content, but poor in organic carbon. An excess of  $\text{Na}^+$  has antagonistic effect on the absorption of Ca and  $\text{Mg}^+$  and thereby may have depressing effect on the availability of phosphorus.

The word transformation refers to the conversion and inter-conversion of one form of phosphorus into another form. This inter-conversion in phosphorus was found mostly in inorganic forms. The transformation of phosphorus is greatly related to fixation and availability of phosphorus in soil and therefore, serves as a guide for suggesting a successful P fertilization programmed for given area. This fact emphasizes the study of inorganic phosphorus in soil. The transformation of inorganic P is observed mostly in saloid-P, Al-P, Fe-P and Ca-P forms, respectively.

The availability of phosphorus in influenced by various factors viz. physico-chemical properties of soil, moisture, temperature, organic matter, pH, lime, incubation period etc. In relation to phosphorus availability would be paramount importance in working out at successful phosphorus fertilization particular soil types in region. Phosphorus uptake is enhanced by the Addition of organics due to production of organic acids which in turn, transform P from Non-utilizable form to plant utilizable form (**Ivanova et al., 2006**). Thus, the incorporation Of FYM improves soil health and crop yield (**Dotaniya, 2012**)

## **Material and methods**

The experiment was conducted during January 2020 – May 2020 at experimental field, Department of Entomology, C.S.A. University of Agriculture and Technology, Kanpur

Nagar (U.P.). An Incubation study was conducted during January 2020 – May 2020 under “Laboratory condition” Department of Soil Science and Agricultural Chemistry.

The soil collected directly from the field from depth of 0-20cm with the help of Kudali were dried, crushed and passed through 2 mm sieve after homogenizing the whole material for evaluating inorganic P fraction at different interval (0, 15, 30, 60 and 90 days). It was mixed thoroughly in order to make it homogeneous before use. The mechanical composition of the soil as sand 58.3% in normal soil silt 25.4% clay 12.2% and silty loam of textural class. The physical and chemical properties of the used soil as  $p^h$  7.7 EC 0.7  $ds\ m^{-1}$  exchangeable  $Ca^{++}, K^{++}, Mg^{++}$  according to 8.5, 1.42, 2.51 & EC 9.8  $c\ mol\ kg^{-1}$  by Jackson method employ 1973 & 1968. Field capacity 22.42 %, by piper 1966, organic carbon 0.4 % by Walkley and black, 1934. Total nitrogen 0.44 kg / ha by Jackson, 1968, available major nutrient as N 180 kg by Subbiah and Asija 1956 and available P 13.0 kg / ha by Olsen et.al. 1954 method and available Ca-P, Al-P and Fe-P of 272, 70.7 & 12.2 ppm used employed method by Jackson, 1957.

An incubation study was carried out to obtain objectives of the present investigation at C.S. Azad University of Agriculture and Technology, Kanpur during Jan. 2020-May 2020 under laboratory condition. To obtain different fraction of phosphorus under field capacity, in all three experiments were conducted kankar soil condition to determine Ca-P, Al-P and Fe-P as influenced by different treatments. The experiment comprising six treatments. Gas control (T1), Sun hemp 10 tones/hr (T2), FYM@10 to/ha (T3), 100ppm phosphorus (T4), 100 ppm phosphors + sun hemp (T5) and 100ppm phosphors+ FYM (T6) Moisture at field capacity condition were maintained in all the 6 experiments. Field capacity condition was maintained by weighing the beaker and addition of loss of water every day. 50g of well ground soil was kept in 500ml beaker. Organic matter (through FYM and Sunhemp) @ 10 tonnes  $ha^{-1}$  were incorporated in respective beakers and inorganic P were added through  $KH_2PO_4$  solution @ 100 ppm. Soil samples were collected with the help of stainless-steel spatula after homogenizing the whole material for evaluating inorganic P fraction at different interval (0, 15, 30, 60, 90 days).

## **Result and discussion**

### **Availability of Ca-P fraction**

Observation presented in Table showed that addition of organic matter either in the form of FYM or Sunhemp (*C. juncea*) increase the Availability of Ca-P. Availability of Ca-P was observed to have further enhanced when organic matter (Sunhemp or FYM) was supplemented with phosphorus. Application of phosphorus alone, however, did not have significant effect on the increase of Ca-P. Among organic materials, Sunhemp (*C. juncea*) appeared to be more effective than FYM in improving Ca-P content of the soil. Observation further revealed that irrespective of incubation period, the maximum available Ca-P to the extent of 308 ppm was noted in the treatment T<sub>5</sub> followed by T<sub>6</sub> with a value of 295. With the advancement of incubation period Ca-P decreased in all treatments significantly. The lowest content of Ca-P was recorded in T<sub>1</sub> control (243 ppm). The maximum value of Ca-P to the extent of 357 ppm was recorded on first day of incubation in treatment T<sub>5</sub> followed by T<sub>6</sub> value being 336 ppm. Irrespective of treatment, available Ca-P was maximum i.e., 308.2 ppm at first day of incubation and was lowest at 90<sup>th</sup> day of incubation (235.3 ppm). These results are in accordance with the findings of *Saha et al., (2022), Zhao et al., (2019) and Meena et al., (2018)*

**Table-1: Effect of added phosphorus and organic matter on the availability of Ca-P fraction in normal soil at field capacity**

Treatments	Incubation period (days)					Mean
	0	15	30	60	90	
T <sub>1</sub> : Control	280	240	248	225	220	<b>243</b>
T <sub>2</sub> : Sunhemp (10 tons ha <sup>-1</sup> )	299	265	275	240	238	<b>263</b>
T <sub>3</sub> : FYM (10 ton ha <sup>-1</sup> )	290	250	261	231	228	<b>252</b>
T <sub>4</sub> : 100 ppm Phosphorus	285	245	255	227	222	<b>247</b>
T <sub>5</sub> : 100 ppm Phosphorus + Sunhemp	357	320	325	280	259	<b>308</b>
T <sub>6</sub> : 100 ppm Phosphorus + FYM	336	309	313	270	245	<b>295</b>
<b>Mean</b>	<b>308.2</b>	<b>271.5</b>	<b>279.5</b>	<b>245.5</b>	<b>235.3</b>	

#### Availability of Al-P fraction

Results presented in the Table-2 clearly showed that incorporation of organic matter either in the form of Sunhemp or FYM increased Al-P significantly, Sunhemp being more effective than FYM. It was further observed that application of phosphorus either alone or that in combination with organic matter enhanced Al-P content significantly over control. The maximum Al-P content, irrespective of incubation period, was recorded under treatment T<sub>5</sub> (80.9ppm) followed by T<sub>6</sub> (76.3ppm). Observation further revealed that with increase in incubation period Al-P content invariably decreased in all treatments including control. The maximum Al-P content to the level of 105.5 ppm was noted on initial day of incubation in the treatment T<sub>5</sub> followed by T<sub>6</sub> (100.2ppm). Irrespective of treatment available Al-P was maximum to the extent of 89.5ppm at the initial day of incubation which gradually decreased to the minimum value of 44.9 at the end of 90<sup>th</sup> day of incubation. These results are in confirmation with finding of **Bhattacharya et al., (2015)**, **Pal et al., (2018)**, **Patel et al., (2020)** and **Dotaniya et al., (2019)**

**Table-2: Effect of added phosphorus and organic matter on the availability of Al-P fraction in normal soil at field capacity**

Treatments	Incubation period (days)					Mean
	0	15	30	60	90	
T <sub>1</sub> : Control	67.0	60.0	53.2	40.2	33.0	<b>50.7</b>
T <sub>2</sub> : Sunhemp (10 tons ha <sup>-1</sup> )	90.3	72.0	63.2	47.3	40.0	<b>62.6</b>
T <sub>3</sub> : FYM (10ton ha <sup>-1</sup> )	75.5	67.3	60.2	44.2	36.3	<b>56.7</b>
T <sub>4</sub> : 100 ppm Phosphorus	98.5	83.0	70.2	58.3	48.3	<b>71.7</b>
T <sub>5</sub> : 100 ppm Phosphorus + Sunhemp	105.5	90.3	79.3	71.3	58.3	<b>80.9</b>
T <sub>6</sub> : 100 ppm Phosphorus + FYM	100.2	88.3	75.3	64.3	53.2	<b>76.3</b>
<b>Mean</b>	<b>89.5</b>	<b>76.8</b>	<b>66.9</b>	<b>54.3</b>	<b>44.9</b>	

#### **Availability of Fe-P fraction**

Observation recorded in Table-3 showed substantial increase in the availability of Fe-P due to application increase of either Sunhemp or FYM when supplemented with or without phosphate. Right from the start incubation period, Maximum available Fe-P content was recorded under T<sub>5</sub> (16.0 ppm) followed by T<sub>6</sub> (15.7 ppm). This trend continued till the 90<sup>th</sup> day of incubation period. Lowest mean value of Fe-P content to the extent treatment T<sub>1</sub> (control). Fe-P (9.3 ppm) was recorded under treatment T<sub>1</sub> (control). A scrutiny of the data

presented in the table further revealed that concentration of Fe-P, irrespective of treatments, slightly decreased on 15<sup>th</sup> day of incubation over initial value which afterward gradually increased up to 90<sup>th</sup> day of incubation period. Maximum Fe-P content to the level of 16.0 ppm was recorded under treatment T<sub>5</sub> followed by treatment T<sub>6</sub> (15.7 ppm). Irrespective of treatments, available Fe-P was maximum to the level of 13.8 ppm at the initial day while lowest of 10.6 ppm was recorded on 15<sup>th</sup> day of incubation. These results are in conformity with finding of Von Wandraszka (2006), Mishra (1994) and Mitran *et al.*, (2016)

**Table-3: Effect of added phosphorus and organic matter on the availability of Fe-P fraction in normal soil at field capacity**

Treatments	Incubation period (days)					Mean
	0	15	30	60	90	
T <sub>1</sub> : Control	11.5	7.5	8.8	9.0	9.5	<b>9.3</b>
T <sub>2</sub> : Sunhemp (10 tons ha <sup>-1</sup> )	13.0	8.9	9.2	9.8	11.0	<b>10.4</b>
T <sub>3</sub> : FYM (10 ton ha <sup>-1</sup> )	12.3	8.0	9.0	9.6	10.6	<b>9.8</b>
T <sub>4</sub> : 100 ppm Phosphorus	14.2	10.2	11.8	12.8	13.0	<b>12.4</b>
T <sub>5</sub> : 100 ppm Phosphorus + Sunhemp	16.0	15.0	16.1	17.0	17.8	<b>16.4</b>
T <sub>6</sub> : 100 ppm Phosphorus + FYM	15.7	14.2	15.3	16.1	16.8	<b>15.6</b>
<b>Mean</b>	<b>13.8</b>	<b>10.6</b>	<b>11.7</b>	<b>12.4</b>	<b>13.1</b>	

### Available phosphorous

Results presented in the Table-4 clearly indicated the beneficial effect of organic matter on enhanced content of Olsen's 'P'. Significantly increased content of Olsen's 'p' was perceptible when soil was mixed with phosphorus. Available 'P' content further increased when phosphorus was mixed with organic matter, Sunhemp being more effective than FYM. Maximum content of Olsen's 'P' to the extent of 19.3ppm was recorded on initial day in the treatment T<sub>5</sub> followed by T<sub>6</sub> (18.4 ppm) which maintained its increase with the advancement of incubation period to the extent of 27.6 ppm and 26.7 ppm respectively till 60<sup>th</sup> day. These values, however, declined on 90th day to 25.6 ppm and 24.5 ppm in the treatment T<sub>5</sub> and T<sub>6</sub> respectively. Irrespective of treatments the initial value of Olsen's 'P' to the extent of 12.75 ppm increased to a value of 19.3 ppm on 60<sup>th</sup> day which subsequently decreased to a value of

16.15 ppm. This is consistent with the finding of *Trivedi et al. (2010)*, *Meena et al. (2018)* and *Krishna et al. (2021)*.

**Table-4: Effect of added phosphorus and organic matter on the availability of Olsen ‘P’ in normal soil at field capacity**

Treatments	Incubation period (days)					Mean
	0	15	30	60	90	
<b>T<sub>1</sub>: Control</b>	6.5	8.5	10.3	11.0	6.0	<b>8.46</b>
<b>T<sub>2</sub>: Sunhemp (10 tons ha<sup>-1</sup>)</b>	7.5	10.5	12.5	13.5	9.8	<b>10.76</b>
<b>T<sub>3</sub>: FYM (10 ton ha<sup>-1</sup>)</b>	7.0	9.5	11.5	12.5	8.7	<b>9.84</b>
<b>T<sub>4</sub>: 100 ppm Phosphorus</b>	17.8	20.2	22.3	24.7	22.3	<b>21.46</b>
<b>T<sub>5</sub>: 100 ppm Phosphorus + Sunhemp</b>	19.3	23.5	25.6	27.6	25.6	<b>24.32</b>
<b>T<sub>6</sub>: 100 ppm Phosphorus + FYM</b>	18.4	22.3	24.2	26.7	24.5	<b>23.22</b>
<b>Mean</b>	<b>12.75</b>	<b>15.75</b>	<b>17.7</b>	<b>19.3</b>	<b>16.15</b>	

## Conclusion

Based on laboratory experiment, it was concluded that with advancement in time of incubation the attainability of Al-P, Ca-P decreased under field capacity while Fe-P either increased marginally at field capacity in kankar soil condition. Application of organic matter either in the form of Sunhemp or FYM along with phosphorus proved very useful in improving available-P content of the soil. Sunhemp proved more beneficial than FYM in increasing Fe-P, Al-P, and Ca-P as also Olsen’s P content in the soil. Application of phosphorus alone produced significant effect on Al-P, Fe-P as also on Olsen’s P. Ca-P, however, did not increase significantly with the application of phosphorus. Based on experimental results it can be inferred that native as well as fertilizer phosphorus efficiency can be insured if soil is supplemented with organic matter preferably through Sunhemp as green manuring.

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