International Journal Of Engineering Research And Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 13, Issue 12 (December 2017), PP.59-62

Phosphorus: Analysis And Use in Agriculture

Kiran[1],Dharamveer,[2]Bhupendra[3]
[1]*Institute of Environment & Development Studies, Bundelkhand University, Jhansi, India*
[2]*Soil Testing Centre, Jhansi, India*
[3]*Department of Botany, Bundelkhand University, Jhansi, India*
Corresponding Author: Kiran

ABSTRACT: In many agricultural systems, phosphorus (P) is one of the most limiting mineral nutrients for plant production. Phosphorus in agriculture is the second most growth limiting macronutrient after nitrogen, its proper management in soil contributes significantly to sustainable crop production. In such soils wherever yield is restricted as a result of low Phosphorus concentration, application of comparatively higher quantity of mineral phosphorus fertilizers is that the only way to enhance soil phosphorus. The commonly phosphorus fertilizers that contain P_2O_5 are Single superphosphate (16% P_2O_5 Granulated) and Di ammonium phosphate. Thus, the status of soil phosphorus as a major contributor to overall soil fertility, or the ability to produce crops, was improved.

Date of Submission: 27 -11-2017 Date of acceptance: 16-12-2017

I. INTRODUCTION

Phosphorus (P) is essential to all known life forms because it is a key element in many physiological and biochemical processes. Phosphorus is one of the seventeen essential nutrients required for plant growth [1]. Plants require adequate P from the very early stages of growth for optimum crop production [2] [3]. A component of every cell in all living organisms, phosphorus is indispensable and cannot be replaced by any other element. Phosphorus occurs in complex DNA and RNA structures which hold and translate genetic information and so control all living processes in plants, animals and man. It is an essential component of the energy transport system in all cells. Phosphorus is not a rare element. It is eleventh in order of abundance in the earth's crust but the concentration in many rocks is very small. However, there are deposits which are sufficiently rich in phosphorus that extraction is commercially viable. Humans & animals conjointly have to be compelled to get an adequate supply of phosphorus from their food and feeding stuffs. Phosphorus deficiency affects several of the essential processes on that the lifetime animal depends, even as it will in plants [4]

Phosphorus in plants

Phosphorus is one among the diffusion restricted major nutrient that is crucial for plant growth. It's associate integral a part of the cellular activities of living organisms. It's an outlined role in plant metabolism like biological process, development, and chemical process, breakdown of sugar, nutrient transport inside the plant, transfer of genetic characteristics from one generation to a different and regulation of metabolic pathways [5]. Phosphorus constitutes about 0.2% of plant dry weight [6]. Phosphorus is one of the primary structural elements of membranes that surround plant cells. It concerned within the synthesis of proteins and vitamins and happens in necessary enzymes Phosphorus is taken up by plant roots from the water in the soil and the soil solution. Phosphorus is that the second most copious mineral component within the human body (the initial is calcium), accounting for over 20 % of the body's minerals. Calcium phosphates, for instance, area unit the foremost constituent of the skeletal bones and teeth and contain 85 % of the body's total phosphorus. Lack of phosphorus not solely affects bone structure, however additionally craving, growth and fertility.

Phosphorus in Agriculture

Until comparatively recent times the growth of plants and animals, and hence the productivity of agriculture, was limited by a lack of phosphorus since only small amounts are released annually from rocks and soil minerals by weathering. Moreover, a large fraction of total soil P is in organic form in many soils and these forms are not directly available to plants [7]. Many of the agricultural soils within the developing countries specially are phosporus deficient [8] and have an unfavorable condition for phosphorus [9]. It's calculable that crop productivity is restricted by phosphorus deficiency on over four-hundredth of the globe cultivatable lands [10]. Additionally, world's resources of phosphorus are limited [11].

As farmers began to use fertilizers within the nineteenth century, levels of plant on the market phosphorus in several soils were still terribly low. This meant that there was very little response to alternative nutrients, particularly Nitrogen, till phosphorus was applied, i.e. phosphorus was the limiting nutrient to crop growth. A range of phosphatic fertilizers are available to farmers. Some contain solely phosphorus, others contain two or additional nutrients. The variety of such fertilizers that contain Nitrogen, phosphorus and Potassium in numerous proportions. The proportions are a unit adjusted to satisfy the requirements of a particular crop and to permit for the extent of plant offered nutrients within the soil.

The some common phosphate fertilizers that contain $P_2O_5$are Mono-ammonium phosphate 52%, Di-ammonium phosphate 46%, Triple superphosphate 46%, and Single superphosphate 18-20%. The phosphorus in mineral fertilizers like superphosphate is mentioned as inorganic phosphorus. This can be to tell apart it from the phosphorus within the advanced organic molecules found in living tissues and animal excreta, that is thought as organic phosphorus Farmyard manure is classed as organic manure however sixty to eightieth of the phosphorus it contains is, in fact, inorganic phosphorus.

Soil phosphorus and its availability

In human nutrition the main focus is on proteins, starch, sugar, fibre and vitamins, all products manufactured for us by plants or from plants via animals. However the plant nutrition is considered in terms of nitrogen, phosphorus, potassium, carbon, sulphur, hydrogen etc elements, required by the plant. Plant roots take up all nutrients from the solution within the soil apart from carbon, hydrogen and oxygen, which are acquired from carbon dioxide within the air via the leaves and therefore water within the soil. The chemistry of phosphorus within the soil is complicated as a result of the phosphorus is related to any completely different compounds to that it's certain with a spread of bonding energies or strengths. Once phosphatic fertilizers are added to soil, solely a fraction of the phosphorus is obsessed by the plant root. Mass flow and diffusion govern the movement of P ions in soil, with diffusion being of primary importance [12] [13].

The remainder becomes attached to the surface to soil particles. Wherever the attachment is weak, the phosphorus will transfer back to the soil solution. When the initial adsorption, any reactions cause assimilation, which suggests that the bond is stronger and also the phosphorus become less readily available. The speed of those reactions and so the speed at that a deficiency in phosphorus becomes apparent rely significantly on the type and size of the mineral particles, the presence of different components like aluminium, iron and calcium, soil acidity and organic matter.About 75% of the entire Phosphorus in soils is in inorganic forms, over 20% is organic Phosphorus and some percent is in soil microorganism biomass [14]. Organic phosphorus in soil is often associated either with soil organic matter (humus) or recently accessorial organic debris coming from plants or animals. These organic molecules cannot be used directly by plants. They have to be breakdown by soil microbes to to release inorganic phosphate ions which can be taken up by plant roots or enter into the same reactions as other fertilizer phosphate ions.

Available phosphorus and Recommendation

For agriculturalists, it is useful to know the quantity of phosphorus in the soil solution and in the readily available pool. Phosphorus is extracted with a suitable reagent from a representative soil sample for analysis. Available phosphorus analyzed by Olsen's method [15].

Reagent

Extract solution- Dissolved 42.0 g of $NaHCO_3$ in 1000 ml of Distilled water, adjust pH 8.5by adding10 % NaOH solution.

H_2SO_4 Solution 5N- Add 141ml of H_2SO_4 to 800 ml of distilled water.

Phosphate solution for standard curve- Dissolved 0.439 g of potassium dihydrogen phosphate into 1 litre volumetric flask and added 500 ml distilled water and salt disolved. Dilute the solution to 1 litre with distilled water. Add 5 drops of toluene to diminish microbial activity (0.1mg of P/ml). Dilute the 20 ml of this solution to 1 litre with distilled water. This solution contains 2 ug P/ml.

Procedure

- Weight 2.5g 2mm air dried soil (0.1g accuracy) in to a 150 ml Erlenmeyer flask.
- Then added 50ml of Olsen's reagents (soil to solution ratio of 1:20 and shake on the reciprocating shaker for 30 min. (180 + oscillations/min.).
- Similarly run a blank without soil.
- Filter through Whatman No. 40 or 42 filter paper into a clean and dry beaker. Shake the flask immediately before pouring suspension into funnel.

- Place a 5ml aliquot of the extracts in a 25 ml volumetric flask and acidify with 2.5M H_2SO_4 to pH-5.0 .Added distilled water to 20 ml and then added 4 ml of reagent B, after waiting for 10 min., read the intensity of blue color on spectrophotometer or calorimeter as described for standard curve.

For preparation of standard curve different concentration of phosphorus (1, 2, 3, 4, 5 and 10 ml of 2ppm phosphorus solution) are taken in 25 ml, volumetric flasks. Prepare the standard curve of phosphorus in the range of 0.08 ug/ml to 0.80 ug/ml. The curve was plotted taking the colorimeter reading on vertical axis and the amount of phosphorus in the horizontal axis.

Calculation

Olson's P (kg/ha) = $R \times (V/v) \times (1/S) \times (2.224 \times 10^6 / 10^6)$

= $R \times (50/5) \times (1/ 2.5) \times 2.24$ = ug P x 8.96

Where,

V= total volume of extractant (50ml)

V = Volume of aliquot taken analysis (5ml)

S= Wt. of soil (2.5gm)

R= Wt. of P in the aliquot in ug (from standard cure)

After analyzing the phosphorus in soil

The amount of phosphorus extracted will give an indication of how the crops will respond to a fresh application of phosphatic fertilizer; high, medium or low responsiveness. The yield of a crop grown on a "highly responsive" soil, for example, will be greatly increased by applying phosphorus. On other soils, the increase in yield will be less, and there may be no increase in yield on soils with substantial readily available phosphorus reserves. After analyzing the sample of soil, if available phosphorus is high, medium and low then the application of phosphorus fertilizers are recommended as follows on crop or variety of wheat.

S. No	Available phosphorus*	Crop & Variety	Phosphorus fertilizer*	
1	Medium (13Kg/ha)	Wheat	Single superphosphate (16% P2O5 Granulated)	281 Kg/ha
			Diamonium phosphate (16:44:0)	102 Kg/ha
2	Low (9 Kg/ha)	Wheat	Single superphosphate (16% P2O5 Granulated)	375 Kg/ha
			Diamonium phosphate (16:44:0)	136 Kg/ha
3	High (27Kg/ha)	Wheat	Single superphosphate (16% P2O5 Granulated)	125 Kg/ha
			Diamonium phosphate (16:44:0)	45 g/ha

*Soil testing centre, Jhansi

Phosphorus in Agriculture and Sustainable use

Phosphorus is an important nutrient for plants, and within the past, food production was usually restricted by its restricted availableness. Maintaining levels of obtainable phosphorus within the soil-plant-animal system continues to be vital to make sure enough plant growth and healthy animals. This has not only resulted in to almost barren and poor quality pastures but has also given birth to various socio-economic evils [16].

Sustainable crop production aims at maintaining high crop yield while not adversely affecting ecosystems to satisfy the requirement of current also as future generations [17]. Governments promoted agricultural policies that aimed toward rising self-reliance in agricultural manufacture. This usually needed the development of soil fertility and therefore the prevailing recommendations for nutrient inputs were for larger amounts of phosphorus, than were being removed by the harvested crop. Thus, the soil phosphorus as a significant contributor to overall soil fertility or the ability to produce crops, was improved. Throughout this era the introduction of crop varieties with a better yield potential demanded a corresponding increase within the input of nutrients. The idea of integrated plant nutrient management presents another chance for rising nutrient cycles, as farmers are inspired to carefully consider the necessity for all the nutrient inputs needed to optimize crop production. During this means the farmer maximizes his monetary returns whereas minimizing any adverse impact on the surroundings. In terms of phosphorus, this idea implies that each one out there sources taken be taken into consideration , as well as soil phosphorus similarly as that contained in applied manures and mineral fertilizers.

II. CONCLUSION

Therefore, maintenance of soil P at a target worth through either of the subsequent ways: application of P fertilizers, periodic incorporation of crop residue, and application of organic manures would be essential for sustainably higher crop yield. Requirements for analyses of nutrient in soil systems need that the farmer keeps correct records of the nutrient applied and removed within the harvested crop so there's proof that the scale of the nutrient balance doesn't exceed the limit set for every nutrient. For phosphorus, such approach is suitable on condition that the soil is at, or near, the important price. However, wherever soils are below this level, farmers got to be allowed to use sufficient phosphorus not solely to make sure optimum yields, however conjointly to accumulate the acceptable reserves so optimum yields are obtained within the future.

REFERENCES

[1]. Raghothama, K.G. 1999. Phosphate acquisition. Annual Review of Plant Physiology and Plant Molecular Biology 50,665-693.

[2]. Grant, C. A., Flaten, D. N., Tomasiewicz, D. J. and Sheppard, S. C. 2001. The importance of early season P nutrition. Can. J. Plant Sci. 81: 211–224.

[3]. Grant, C., Bittman, S., Montreal, M., Plenchette, C. and Morel, C. 2005. Soil and fertilizer phosphorus: effects on plant P supply and mycorrhizal development. Can. J. Plant Sci., 85, 3–14.

[4]. Johnston, A. E. and Steen, I. 2000. European fertilizer manufacture association. 11-22.

[5]. Theodorou, M. E. and Plaxton, W. C. 1993. Metabolic adaptations of plant respiration to nutritional phosphate deprivation. Plant Physiol., 101, 339–344.

[6]. Schactman, D. P., Reid, R. J. and Ayling, S. M. 1998. Phosphate uptake by plants from soil to cell. Plant Physiol., 166, 447–453

[7]. Smith, F.W. 2001. Plant response to nutritional stresses. In: Hawkesford MJ, Buchner P (eds.) Molecular analysis of plant adaptation to the environment. Kluwer Academic Publishers. The Netherlands. pp 249-269.

[8]. Vlek, P.L.G., Koch, H. 1992. The soil resource base and food production in the developing world: special focus on Africa. Gättinger Beitrage zur Landund Forstwirschaft in den Tropen und Subtropen 71,139-160.

[9]. Soltan, S., Römer, W., Adgo, E., Gerke, J., Schilling, G. 1993. Phosphorus sorption by Egyptian, Ethiopian and German soils and P uptake by rye (Secale cereale L.) seedlings. Z. Pflanzenenähr. Bodenkd. 156,501-506.

[10]. Vance, C.P. 2001. Symbiotic nitrogen fixation and phosphorus acquisition: plant nutrition in a world of declining renewable resources. Plant Physiology 127,390-397.

[11]. Vance, C.P., Uhde-Stone, C., Allan, D. 2003. Phosphorus acquisition and use: critical adaptation by plants for securing non-renewable resources. New Phytologist 15,423-447.

[12]. Barber, S. A. 1984. Soil nutrient bioavailability: A mechanistic approach. John Wiley & Sons Inc., New York, NY. 398 pp.

[13]. Barber, S. A., Walker, J. M. and Vasey, E. H. 1963. Mechanisms for the movements of plant nutrients from the soil and fertilizer to the plant root. J. Agric. Food Chem. 11: 204–207.

[14]. Morel C., Tunney, H., Plénet, D. and Pellerin, S. 2000. Transfer of phosphate ion between soil and solution. Perspectives in soil testing. J. Envon. Qual. 29: 50–59.

[15]. Olsen SR, Cole CV, Watanable FS, Dean LA (1954). Estimation of available phosphorous in soils by extraction with sodium bicarbonate. Circ. U.S. Dep. Agric. 939.

[16]. Kiran, Amit Pal and Rajdeep Kudesia (2009). Soil quality of degraded land of Bundelkhand region with special reference to Jhansi district of Uttar Pradesh. Journal of Phytology. 1(5): 328–332.

[17]. Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R., Polasky, S. 2002. Agricultural sustainability and intensive production practices. Nature 418, 671-677.

Kiran. "Phosphorus: Analysis And Use in Agriculture." International Journal Of Engineering Research And Development , vol. 13, no. 12, 2017, pp. 59–62.