Frank Notes

Satish Chander

Importance of Phosphorus and Potash in Indian Agriculture

Phosphorus (P) plays many key roles in crop growth. It is referred to as "king-pin" of agriculture. Phosphorus-containing adenosine triphosphate (ATP) is the "energy currency" of the plants. Potassium (K) regulates many enzymes involved in photosynthesis, metabolism and translocation of carbohydrates and proteins. Besides being critical in controlling plant-water relations, potassium imparts resistance to plants against disease and pest attack.

Nitrogen is the most yield-limiting nutrient in Indian agriculture (63% samples low & 26% medium in available N), followed by phosphorus (42% low & 38% medium) and potassium (13% low & 37% medium). World consumption of plant nutrients in 2016 was 110.6 million tonnes (Mt) N, 40.6 Mt P_2O_5 and 33.2 Mt K_2O in 2016. India's consumption figures were 17.4 Mt N, 7.0 Mt P_2O_5 and 2.4 Mt K_2O in 2015-16. Nutrient-wise consumption patterns follow the occurrence of magnitude of their deficiencies. This macroscopic comparison of nutrient consumption does not tally with uptake of the individual nutrients by the crops. Average K uptake by crops on unit area in India is almost similar to that of N; in some fruit and commercial crops, it even exceeds N. Phosphorus removal is one-fourth to one-half of N and K. Use efficiency of applied N, P and K across the crops varies from 33 to 50, 15 to 25 and 55 to 60%, respectively. Unlike nitrogen, P and K occur in soil as the inorganic compounds and/or the constituents of the bulk inorganic phase. Both P and K are immobile in the soil and remain at the site of application for a long time, unlike nitrogen, which if not taken up by the plants either goes to the air or surface water. While nitrogen figures at the top of the plant nutrition strategies, harnessing full yield potential of crops is impossible without the inclusion of P and K in the fertilization schedule.

Portion of P added through the fertiliser (15-25%) is taken up by the crop plants; the unutilized P is either irreversibly adsorbed on soil matrix or reacts with iron, aluminium and calcium ions to precipitate as the sparingly soluble phosphates. Long-term fertiliser experiments on different cropping systems across soil types indicate accumulation and build up of available P. Over-usage of P in high runoff and erosion-prone ecosystems makes significant contributions to eutrophication. Phosphorus management poses typical problems on high P-fixing acidic red and lateritic soils. Continuous fertilization of acid soils with acid-forming nitrogenous fertilisers leads to further aggravation of harmful effects of soil acidity. Transformation of the native and added P into highly insoluble iron and aluminium phosphates reduces the efficiency of both native as well as applied P. Crop failure with application of N-fertilisers on these soils commonly occurs because of severe limitations imposed by acute P deficiency and in such soils, P replaces N as the number one limiting nutrient.

Potassium is among the abundant nutrient elements in the earth's crust and also the nutrient removed by crops in large amounts. K exists in four principal forms in soil namely solution, exchangeable, non-exchangeable and structural K. First three forms exist in a state of dynamic equilibrium and constitute a pool from which the plants meet their K requirement. These are adequate in majority of the Indian soils. Light textured red and lateritic soils dominated by kaolinitic clay are low in exchangeable as well as non-exchangeable K. Acid leached soils of high rainfall areas suffer from K deficiencies. Soils high in available K make the crops to luxuriously accumulate K which is not translated into corresponding yield increase but does not cause yield reductions either.

Numerous studies across the globe including India showed that heavy K removal by crops was not reflected in the changes in available K status of soil

(water soluble plus exchangeable K) as an equilibrium exists between exchangeable and non-exchangeable K. The non-exchangeable K accounts for about 70% of total K uptake by the crop. It may be mentioned here that the crop response to K application is illusive in nature. There are situations wherein crop response to K application is not observed on soils low in available K and vice-versa. Studies conducted in India have shown that the available K alone is not adequate in describing K responses. Both exchangeable K and non-exchangeable K together should be considered to describe the observed K responses. Potassium fertility maps for the country based on both exchangeable and non-exchangeable K have been developed and their use in drawing up K recommendations is being made.

There has been significant growth in fertiliser consumption in the last 50 years. Favourable fertiliser policies and promotional efforts during 1970s and 1980s encouraged nutrient use in a balanced manner. However, two policy decisions namely, decontrol of P and K fertilisers in August 1992 and selective introduction of Nutrient Based Subsidy (NBS) Scheme with effect from 1st April, 2010 have adversely affected the balanced fertilisation programme. Both these policy decisions created distortion in urea *vis-à-vis* P&K prices and hence adverse NPK use ratio. The drop in P&K consumption after 2010-11 has compounded the problem of P&K mining in Indian soils. Indian agriculture operates with net negative balance of 2.3, 2.1 and 8.6 Mt per year with respect to N, P and K, respectively.

Policy makers should address the issue of almost complete dependence on imports to meet the P&K requirement of the country. There is a need for investment both in terms of financial and human resources.

Magnitude of K mining from soil is alarming and needs urgent attention.

Integrated nutrient management, making conjoint use of chemical fertilisers, biofertilisers, on- and off– farm organic sources, green manures, etc., and exploiting synergistic water-nutrient interactions is the best prescription for sustenance of soil health. Government policies of issuing soil health cards to all 138 million farm holdings, promotion of the use of compost through market development assistance and use of water soluble fertilisers especially in high value crops through fertilization in water-scarce (dryland) areas are steps in right direction. These steps should also help in P and K inclusive balanced fertilization.

Important issue specific to K fertilisation in India is whopping negative K balance and country's total dependence on imports to meet the K demand in agriculture. In case of phosphorus, the dependence on imports is to the tune of 92%. Therefore, there is an urgent need to explore the indigenous sources of P&K to at least partially meet the country's large requirement. Other strategies like use of on- and off– farm K-rich sources and use of potassium solubilizing microorganisms (KSM) including *Bacillus mucilaginous* can supplement the crop requirements for K. Recent reports suggest that India has vast resources of polyhalite, glauconite, mica waste, other K-containing rocks and minerals, etc., that can successfully be utilized for meeting the K needs of crops and minimize the imports. Utilization of poor quality indigenous phosphate rocks coupled with microbial interventions is a useful proposition for the organic farming areas like north-east and other hilly states which have gone organic. Use of AM-fungi and K solubilizing microbes in organic system is also an attractive option.

Policy makers should address the issue of almost complete dependence on imports to meet the P&K requirement of the country. There is a need for investment both in terms of financial and human resources to explore all possible resources and all possible manners to meet the ever-growing need of P&K for Indian agriculture.

This issue of Indian Journal of fertilisers is devoted to importance of P and K in Indian agriculture. Eight articles included in the issue cover all the aspects of P and K ranging from use and balances in global and Indian agriculture; distribution, dynamics and transformation in soils; and eco-friendly management strategies for enhancing use efficiencies in the crops and cropping systems. It is expected that this issue will serve as a useful repository of information on P and K at one place. ■