JUST AGRICULTURE
multidisciplinary e-Newsletter

Safe and judicious use of fertilizers

Bhawna Babal[1] and V.K. Phogat[2]

[1]Ph.D. Scholar, Department of Soil Science,

CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur

[2]Emeritus Professor, Department of Soil Science,

CCS Haryana Agricultural University, Hisar

ARTICLE ID: 035

Judicious use of fertilizers refers to the application of fertilizers with good judgment by adopting right source, right quantity, correct method and best time of application suited for a specific soil-crop-climate situation. Judicious use provides high yield, fertilizer use efficiency and profits, and also environmental pollution.

The excessive use of fertilizer causes environment pollution such as nitrate pollution of groundwater, enrichment of nutrients in water bodies resulting in growth of aquatic plants, ammonia volatilization losses and acid rain due to release of other nitrogenous gases. The under dose of fertilizers reduces the yields and creates food insecurity. Hence, fertilizers must be used judiciously and more efficiently.

Fertilizer use efficiency: It refers to the amount of added fertilizer actually used by crop which is measured either by the percentage of added fertilizer nutrient removed by the harvested portion of a crop or kilograms of economic produce (grain yield) per kilogram of nutrient applied.

The efficiency of different nutrient elements as affected by different factors is explained here:

Nitrogen use efficiency: The N use efficiency by the crops varies between 35 to 45 %. This low efficiency (recovery) of N is due to the losses caused by volatilization of N in the form of ammonia, denitrification, leaching and runoff. The nitrogen use efficiency depends not only on rate, time and method of fertilizer application but also on soil and crop management factors, such as land levelling, land preparation, choice of crops and their varieties, time of sowing, plant population, weed control, water management, plant protection and balanced supply of plant nutrients.

JUST AGRICULTURE
multidisciplinary e-Newsletter

The nitrogenous fertilizers are mostly in amide and ammonical forms. Upon conversion into nitrate forms, it becomes very susceptible to loss by leaching. The NH_4^+ in the ammonical fertilizers are adsorbed on surfaces of clay particles which may be utilized directly by certain crops like rice, otherwise they are transformed into nitrates by microbes and taken up by plants. Higher the clay content in soil and its exchange capacity, the better is the nitrogen use efficiency. If the rate of nitrification (conversion of NH_4^+ to NO_3^-) is more than the rate of uptake by the by the crops, then the excess NO_3^- is lost through leaching.

The following practices are generally useful for increasing N use efficiency:

1. Split application of nitrogen is a widely accepted practice for all crops. The basic approach is to apply nitrogen in two or three splits depending upon the peak period of nitrogen requirement of the crop.
2. Use of slow-release nitrogenous fertilizers such as sulphur coated urea (SCU), neem coated urea, *etc.*, increases the nitrogen use efficiency.
3. Use of nitrification inhibitors also increase the N use efficiency. The nitrification inhibitors retard the rate of transformation of NH_4^+ to NO_3^-, thereby making the fertilizer nitrogen gradually available to the crops. Nitrification inhibitors like N-serve, AM, ST, Thio-urea (O replaced by S) increase nitrogen use efficiency.
4. Judicious use of manures and fertilizers also increases the nitrogen use efficiency.
5. Use of balanced fertilizer application.
6. Apply N fertilizer on soil test basis.

Phosphorus use efficiency: The use efficiency of P in crops varies between 20-25%. In phosphorus fertilization, fixation of phosphate is the main problem. Fixation takes place due to presence of clay, amorphous colloids, calcium carbonate, oxides of Fe and Al, *etc.* Water soluble phosphatic fertilizers soon after application to the soil react preferably with iron and aluminium in acidic soils to form sparingly soluble products (initial phosphate reaction products). In normal and alkaline soils, calcium and magnesium carbonates, pH and moisture of soil control the nature of reaction products. The efficiency of phosphatic fertilizers depends primarily on the release of phosphorus from these reaction products rather than from the fertilizer itself.

To increase phosphorus use efficiency, the following practices are generally useful:

JUST AGRICULTURE
multidisciplinary e-Newsletter

1. There should be a minimum contact of the fertilizers with the soil to restrict phosphate fixation, therefore, band placement of water-soluble phosphorus fertilizers just below the seed is preferred for increasing P use efficiency.
2. Combine ammonium and phosphate fertilizers together in band placement.
3. Application of lime in acid soils (to raise the pH) increases the P use efficiency.
4. Enhance the organic matter content of soil by application of organic manures, green manuring and residue incorporation.
5. Improving the activities of P solubilizing microorganisms in the rhizosphere.
6. Use of balanced nutrition, P efficient crop species or genotypes, weed control, supply of adequate moisture, appropriate time and rate of P application increases P use efficiency.

Potassium use efficiency: The K use efficiency varies between 50-60 per cent. In K fertilization, fixation of potassium and leaching losses are the main problems. Potassium use efficiency depends on several factors such as texture, pH, type of clay present, organic matter content, soil erosion, time and method of fertilizer application. Losses of applied potassium occur mainly in sandy soils, organic soils and soils with kaolinite as the dominant clay mineral. The fixation of applied potassium between the clay lattice takes place which reduces its availability to plants. The fixation is nearly absent in soils dominant in 1:1 type of clay and large in soils dominant in 2:1 type of clay. At low pH, due to presence of H^+ and aluminium ions, the K fixation is less and K remain in solution phase, however, as pH increases, the K fixation also increases.

To increase potassium use efficiency, the following practices are generally useful:

1. Liming is the best way to improve fertilizer use efficiency in acid soils. Liming acid soils not only decreases Al but also increases retention of applied K and thereby decreases K leaching.
2. Use appropriate source, method, rate and time of K fertilizers.
3. Use of nutrient efficient crop species is an important management strategy for maximizing potassium use efficiency in crop plants.
4. Incorporation of crop residues in the soils after harvest and application of FYM increases K use efficiency. Soils organic matter is the storehouse of nutrient and water, and reduces the nutrient losses.

Suitability of nitrogenous fertilizers for different soil conditions and crops:

JUST AGRICULTURE
multidisciplinary e-Newsletter

1. For paddy, sugarcane and potato, ammonical and ammonia forming fertilizers, namely, ammonium sulphate, ammonium chloride and urea should be used. If these are not available, ammonia nitrate fertilizers like ammonium sulphate nitrate, ammonium nitrate and calcium nitrate should be used. Ammonium chloride should not be used in chloride sensitive crops like potato, grapes, *etc.*
2. For wheat, nitrate and ammonia forming fertilizers, namely CAN, and ammonium sulphate is either superior to or at par with ammonical and amide sources, namely ammonium chloride and urea.
3. Ammonium sulphate, urea, ammonium sulphate nitrate and CAN are equally effective for maize. However, under high rainfall region ammonium sulphate is better than urea and CAN because nitrate and urea are highly prone to leaching under such conditions.
4. Oilseeds and pulses prefer ammonium sulphate over other N- carriers due to the special role of sulphur in their nutrition.
5. For cotton, generally different sources of N have been found to be equally effective. In jute, NH_4^+ sources proved superior to NO_3^- source.
6. For other field crops, all nitrogenous fertilizers are equally effective.
7. On acid soils or soils low in lime or calcium, continued use of ammonium sulphate, urea ammonium chloride and ammonium chloride and ammonium sulphate nitrate should be avoided. If these fertilizers have to be used on acid soils, lime application is desirable.
8. Nitrate fertilizers such as sodium nitrate and calcium nitrate are basic in nature and should be used in acid soils.
9. Ammonium sulphate is especially suitable for soils deficient in available sulphur and for salt affected soils.
10. A nitrate fertilizer, like sodium nitrate is best suited for top dressing and side dressing when growing crops need nitrogen immediately.
11. In rainy season, use of sodium nitrate should be avoided and apply nitrogenous fertilizers in split dose. In winter or *rabi* season, the nitrogenous fertilizers should be selected on the basis of cheapness per unit weight of nitrogen, as all nitrogenous fertilizers are equally effective and loss of leaching does not usually occur.
12. Amide fertilizers are best suited for foliar spray.
13. On dry soils, NO_3 fertilizers are superior to other form of nitrogenous fertilizers.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Suitability of phosphorus fertilizers for different soil conditions and crops:

Phosphoric acid (H_3PO_4) combines with Ca to form three salts which are sold to cultivators as commercial phosphatic fertilizers:

1. Mono calcium phosphate ($Ca(H_2PO_4)$]- Mono calcium phosphate is readily soluble in water and most important compound in super phosphate and triple super phosphate.
2. Dicalcium phosphate [$Ca_2H_2(PO)_4$]- Dicalcium phosphate is not soluble in water, but dissolve readily in weak dilute acids *i.e.*, citric acid. Fertilizers of this group are dicalcium phosphate, basic slag and rhenania phosphate.
3. Tricalcium phosphate ($Ca_3(PO_4)_2$)- Tricalcium phosphate neither soluble in water nor in weak acids, but soluble in strong mineral acids. Fertilizers of this group are rock phosphate, raw bone meal and steamed bone meal.

Conditions favouring use of fertilizers containing water soluble phosphate:

1. When soil is neutral or alkaline. Under acidic conditions, water soluble phosphoric acid gets converted in to unavailable iron and aluminium phosphates.
2. When a crop requires a quick start
3. For short duration crops like paddy, wheat, jowar, ragi, maize, soybean and vegetable crops.

Conditions favouring use of fertilizers containing citric acid soluble phosphate:

1. When soil is moderately acidic. Under low pH citric acid soluble phosphoric acid gets converted in to monocalcium phosphate or water-soluble phosphate and there are less chances of phosphate getting fixed as iron and aluminium phosphates.
2. Where immediate results in terms of quick start to crops are not so important and where fertilizer can be applied well before growth starts.
3. For long duration crops like sugarcane, tapioca, tea, coffee, *etc*.

Conditions favouring use of fertilizers containing insoluble phosphate:

1. Where the soil is strongly to extremely acidic. Where large quantity of phosphatic fertilizers is required to raise soil fertility. In these soils, the tricalcium phosphate first converted to dicalcium phosphate and then monocalcium phosphate.
2. Where immediate effects are not so important
3. For long duration fruit and plantation crops like tea, coffee, rubber, cocoa, oranges, coconut etc. grown in acidic soils.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Suitability of potassic fertilizers for different soil conditions and crops:

1. Muriate of potash (Potassium chloride): MOP is well suited for all soils and crops except chloride sensitive crops like tobacco, potato, tomato and grapes. Use of potassium chloride is discouraged in saline soils as it increases salt concentration in rhizosphere soil.
2. Sulphate of potash (Potassium sulphate): SOP is used in all soils and crops. It is also suitable for chloride sensitive crops and preferable in salt affected soils. It should not be used in flooded rice where sulphate reduction and hydrogen sulphide toxicity are major problems.

General recommendations for methods of different fertilizer application

1. Nitrogenous fertilizers applied on soil surface reach the plant roots easily and rapidly. As such, these fertilizers should be broadcasted on the soil surface just before sowing.
2. Application of nitrogenous fertilizers on the soil surface followed by irrigation is good enough to meet the nitrogen requirement at critical stage of plant growth.
3. In light soils, nitrogen should be applied after irrigation, however, in medium and heavy textured soils, N should be applied with irrigation water.
4. Since P moves slowly from the point of placement. It should be placed where it will be readily accessible to plant roots. To reduce the fixation of phosphate, P fertilizers should be so placed that these come in to minimum contact with the soil particles and are closer to the plant. Since potassic fertilizers move slowly in the soil, they should also be placed near root zone.

- Apply Ca, S, Zn and Cu fertilizers as soil application *i.e.*, broadcasting followed by incorporation.