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भाकृअनुप-भारतीय मृदा विज्ञान संस्थान

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Application No. 222-02/IISS/RTI/2020

Date: 18/03/2020

To,

Sh. Ranveer
Vpo. Mannivali
Teh. Sadulsahar
Dist. Sri Ganganagar - 335062

Sub: Reply to information under RTI Act, 2005- reg.

Dear Sir,

Please find enclosed herewith the information (four pages) in response to your RTI application No. 222-02/IISS/RTI/2020 dated 20/02/2020 (Registration No. IIOSS/R/E/20/00008 dated 19/02/2020) received at this end via online on 19/02/2020. Kindly acknowledge the receipt of this reply letter along with enclosure (four pages). Further, it is informed that the Appellate Authority is Director, ICAR-IISS, Bhopal and his telephone no. is 0755-2730946.

Encl: Information containing four pages

Yours sincerely,

(R. Elanchezhian)
PS & Nodal Officer RTI cum-CPIO (Scientific)

Date: - 16-03-2020

Reply to RTI No. IIOSS/R/E/20/00008

Information Sought: -

Q. Which of the following phosphatic fertilizer is suitable for acidic soil-

A. Rock phosphate
B. Ammonium phosphate
C. Diammonium phosphate
D. Dicalcium phosphate

Reply is enclosed.

For further reading, refer book "Soil Fertility and Fertilizers" fifth edition by Samuel L. Tisdale et al 1995.

(A.K. Biswas)
PS & I/C HOD
SCF Division

To,
CPIO (Scientific)
ICAR-IISS

Table 5 : **Major routes of N loss, conditions favouring these and general strategies for reducing them to increase N-use efficiency**

Route of N loss	*Conditions favouring loss of N*	*Strategies for reducing N losses*
VOLATILISATION (loss as ammonia from soil surface whether flooded or not)	* sandy soils * fertiliser left on soil surface * neutral-alkaline soils * shallow application in flooded rice soils * hot dry periods	* never leave urea on soil surface, mix it with soil * drill basal dose for upland crops * follow broadcast by hoeing light irrigation etc. practice split application * Use USG in medium-fine textured soils
LEACHING (loss of N from root zone with drainage waters)	* sandy soils * high rainfall areas * heavily irrigated fields (more water per irrigation) * unbalanced fertiliser application leading to poor utilisation of N * more N/split or all N as basal	* add organic matter * split application of N * more splits at higher rate of N application * controlled irrigation * use soil-cured urea * use neem coated urea * more splits for long duration crops/varieties and in high rainfall areas.
DENITRIFICATION (loss of N in gas form resulting from break down of nitrate by soil microorganisms)	* conditions favouring movement of nitrate into lower depth, compacted pockets) * waterlogged soils * addition of nitrate to waterlogged soils * surface application of N to flooded rice soils * high organic matter soils	* improve drainage and soil aeration * in flooded rice, adopt practices which conserve N in ammonium form * use of non-nitrate sources as basal in flooded rice. * place USG or NH_4^+ N 10-15 cm deap in flooded rice paddies.
RUNOFF (loss of N with surface flow during heavy rains or over-irrigation)	* slopy lands * poorly levelled fields * flood irrigation * inadequate moisture conservation steps	* incorporate fertiliser in soil * give controlled and light irrigations * do land levelling * adopt moisture conservation measures (ploughing before rains, bunding, mulching etc.)

Source : H.L.S Tandon, 1988. Fertiliser News, December issue

Ammonium Sulphate : When ammonium sulphate is added to soils, it dissolves in the water and its ammonium (NH_4^+) and sulphate (SO_4^{--}) parts get separated (dissociation). The ammonium of AS follows the same steps as discussed above and its sulphate is either held by soil particles is taken up by the roots or lost through leaching. Similarly ammonium chloride releases ammonium and chloride (Cl^-) ions. Chloride is very weakly held in soils and moves freely with water. Fertiliser calcium ammonium nitrate is made up of two separate materials (i) ammonium nitrate and (ii) calcium carbonate or lime. Ammonium nitrate delivers NH_4^+ and NO_3^- ions in a 50:50 ratio. This ammonium can be further nitrified or used as such.

All these nitrogenous fertilisers (except CAN) leave behind an acidic effect, that is, they lower soil pH. This is because they do not have a basic (alkali) cation to counter the acidity produced during their breakdown to simpler forms (nitrification is an acid forming process). The calcium in CAN neutralises such acidity. Pure ammonium nitrate is acid forming but not when it is processed into CAN which can be seen as a fertiliser that brings along its own acidity neutralising agent.

Ammonium chloride and ammonium sulphate produce about three times more acidity than urea. To neutralise the acid effect per kg of N applied, calcium carbonate needed is 1.7 kg in case of urea, 5.0 kg for ACl and 5.3 kg for AS. This does not mean that every time one uses these N fertilisers, one runs for lime. It means that one should not use them exclusively, watch the long-term effects on soil pH and take corrective measures when needed (pH below 6.0).

Phosphatic Fertilisers

Plant roots do not absorb fertiliser granules as they come out of the bag. When water soluble phosphates are added to the soil, they quickly dissolve in the soil water. Fertilisers SSP, DAP, APS, most NP and NPK complexes (except partly water soluble nitrophosphates and rock phosphate) come in this category. As soon as the fertiliser dissolves, soil constituents such as the oxides of Al, Fe and carbonates of, Ca and Mg are quick to bind this P and form sparingly soluble compounds. Being only slightly soluble they cannot remain in solution and precipitate* out. This is why very little P is found in the soil solution even a day or two after fertiliser application. This is not a cause for undue worry. The soil has a habit of not openly exhibiting all its nutrient wealth.

* to come out of solution in solid form

Plant

Water - soluble P fertiliser + water ----> $H_2PO_4^-$ ---Reacts with---> Al compounds / Fe compounds / Ca compounds ---furnish---> Available P

It is these reaction products of P which keep on replenishing the soil solution in the same way as a well is recharged by ground waters as the water is drawn from it. The importance of each donor fraction depends not on its size but on its solubility and reactivity. The different reaction products (Al-P, Fe-P, Ca-P) together are called as the capacity factor (bank balance) and P in the soil solution as the intensity factor (cash in hand). The capacity sustains and supports the intensity. For plant nutrition, a small intensity is not as bad as a small capacity and a low (miserly) rate of replenishment for long duration crops. Short duration crop however need a fairly good rate of P supply. The division of nutrient pool into capacity and intensity occurs in the case of most nutrients, not just P.

Capacity and Intensity

The P present in soil solution
Is a result of dissolution
It is but a very tiny fraction
of the available nutrient section.

But as P is by roots withdrawn
The capacity factor does not sit calm.
Its various forms are set in motion
Together they recharge the soil solution.

When the capacity itself is weak
The intensity can never be at its peak.
And the soil will tell the standing crop
To ask the farmer to act fast.

The wise farmer then adds some P
Capacity is raised and so is intensity.
A farmer who cares not what to do
Reaps a poor harvest, stays poor too

- HLS Tandon

Single Superphosphate : SSP is made up of two parts (i) the P source monocalcium phosphate (MCP) and (ii) calcium sulphate. When SSP dissolves in soils, its phosphate dissolves fast and reacts as explainded above. The calcium sulphate dissolves slowly. It serves as the source of Ca^{++} and SO_4^{--}. Some Ca^{++} also comes from MCP.

SSP
- monocalcium phosphate ----> dissolves fast --> phosphate + calcium
- calcium sulphate ----------> dissolves slowly --> sulphate + calcium

Diammonium Phosphate : It readily dissolves in the soil and releases ammonium and phosphate ions. Ammonium and phosphate react as explained above. When ammonium N is said to improve P availability as compared to nitrate - N, a possible reason is that when ammonium changes to nitrate, the acidity produced helps to increase P availability. The general reactions of fertilisers can be guessed from their names. For example ammonium phosphate sulphate after dissolving in soil release three types of nutrient ions written in its names. Urea ammonium phosphate likewise provide some urea N, some NH_4 N and some phosphate.

Nitrophosphates : When a partly water-soluble P source (example : nitrophosphate 20-20-0) is added, its water soluble part dissolves quickly and the citrate soluble part dissolves slowly. Once dissolved, it will participate in the same reactions as its water soluble partner did earlier. The N in nitrophosphate is partly in NH_4^+ and partly in NO_3^- form and behaves in the same way as the N of CAN.

Nitrophosphate
- N part – dissolves fast ⟶ 50% ammonium + 50% nitrate
- P part
  - water-soluble portion ⟶ dissolves fast ⟶ phosphate ions
  - not water-soluble portion ⟶ dissolves slowly ⟶ phosphate ions

Rock Phosphate : When a fertiliser such as rock phosphate having little water soluble P is added to a soil, it must wait for an acid to dissolve it*. This is possible in acid soils which can break down rock phosphate and release

* between the rock and the root, acid has to come in somewhere, either in the fertiliser factory or as soil acidity.

its P in soluble form. The rate of reaction is slow because soil acids are very weak (dilute) as compared to the sulphuric acid used in an SSP factory.

When rock P is made soluble, its P enters the soil solution and reacts with soil compounds. The slow action of rock P is an advantage as it slows down the rate of conversion of P into less soluble forms and also enables it to produce a longer residual effect as compared to soluble fertilisers. Conditions which favour the solubility of rock phosphate are:

- low soil pH (less than 5.5)
- optimum moisture, warm temperature
- abundant organic matter
- fine particle size of Rock - P
- maximum contact with soil
- mixing well ahead of sowing

Potassium Fertilisers

All common sources of potash (MOP, SOP, NPK complexes) are readily soluble in water. The reactions of MOP are similar to those of ammonium chloride and those of SOP are similar to ammonium sulphate except that in place of ammonium here one is talking of the release of potassium ions into the solution and the acid forming effect is absent. The potash of NPK complexes behaves as in MOP because MOP is the source of K used in their production. Unlike ammonium, K^+ does not undergo any further chemical changes. Once in the solution, it can be held as an exchangeable cation, absorbed by roots, trapped in between clay plates or lost by leaching.

Sulphur Fertilisers

The reactions of sulphur in AS, SSP, ASP an SOP are very simple and have been discussed above. In arable soils, sulphate remains as such. In highly reduced soils, it can be attacked by bacteria to release H_2S gas somewhat comparable to denitrification in case of nitrate.

When mineral gypsum of phosphogypsum are used, they dissolve in the soil but at a slower rate than soluble fertilisers. Its solubility at room temperature is about 2.5 grams a liter. This is not a problem because there is enough water in moist soils to take care of 200-250 kg gypsum used/ha. The active substance in both of the these is calcium sulphate* which releases Ca^{++} that goes on the exchange sites while $SO_4^{=}$ remains loosely held.

The situation is somewhat different when elemental S or pyrites are used as

* also used as the plaster in case of fractures or broken bones

sulphur fertilisers. Elemental S is oxidised into $SO_4^{=}$ by soil bacteria the most common of which are *Thiobacillus thiooxidans* (thio means sulphur). There on it behaves like any other sulphate source. It takes several weeks to convert the S to $SO_4^{=}$. The reaction is fast when elemental S particles are finer, the contact with soil is maximum and there is a balance between air and moisture. Such a situation calls for mixing of powdered sulphur with the top soil a few weeks before sowing (see the similarity between this and phosphate rock). A fineness of around 100 mesh seems to be good enough. When elemental S is oxidised to sulphate, sulphuric acid is produced. This lowers soil pH which helps to solublise some P and iron as well. Thus elemental S can be used in alkaline calcareous soils for best effect and generally similar comments can made for pyrites. The S in pyrites has also to be changed to sulphate and much of this happens chemically in the presence of air and water. Here also, a fall in soil pH takes place.

Other Fertilisers

Magnesium sulphate releases magnesium cations (Mg^{++}) and sulphate $SO_4^{=}$) anions. The Mg^{++} is held by clay particles and can be absorbed by roots. The above process occurs for most fertilisers in general. When micronutrient salts are added to soil, they dissolve in water and release their nutrient in cationic (Zn^{++}, Cu^{++}, Fe^{++}, Mn^{++}) or anionic ($MoO_4^{=}$, $H_2BO_3^-$, Cl^-) forms. These are partly held on to the exchange complex, partly held by organic matter as metallo-organic complexes and tiny amounts are present in the soil solution at a given time except larger amounts of Cl^-. All sulphate salts also provide S in addition to the main nutrient for which they are used. For example zinc sulphate releases Zn^{++} and $SO_4^{=}$. The sulphate of micronutrient fertilisers performs just like the sulphate in AS, SSP, APS, etc.

When chelated fertilisers are added to soils, they are soluble but the nutrient is bound (protected) by the organic chelate and is not free to dissolve in soil water or take part in reactions like inorganic salts. A good chelated fertiliser should be soluble but stable. It should only release the nutrient near the root surface just before it can be absorbed by the roots. If it releases the nutrient prematurely, then its very purpose is defeated. Because chelating agents are negatively charged organic molecules (ligands) such as EDTA, EDDHA etc. Only nutrients in cationic form Zn^{++}, Fe^{++}, Cu^{++} (not borate or molybdate) can be chelated.

Organic Manures

The reactions of organic manures in soils are basically similar to those of soil organic matter which have been described in chapter 3. The manures release their nutrients by mineralisation. The nutrient forms resulting from