15. **Mixed fertilizers – sources – preparations- their compatibility – advantages**

Mixed fertilizers

For over hundred years the mixed fertilizers are in use besides straight fertilizers. Many fertilizer mixtures are made available now and this account for a major portion of the consumption of N, P and K. Present day statistics show that numerous grades of fertilizers mixtures are manufactured and the fertilizer mixing industry is being considered as one of the major agro- industry.

The following are some of the common term frequently used in the mixed fertilizer industry.

Fertilizer : The substance which is used for the supply of plant nutrients

Mixed fertilizer : A mixture of more than one straight fertilizer which can supply more than one plant nutrient element

Complete fertilizer : A single fertilizer material containing the entire three major plant nutrients viz, N, P and K

Fertilizer grade : This refers to the minimum guarantee with regard to the nutrient content of the fertilizer mixture in terms of N, P and K.

Fertilizer formula : This related to the quantitative expression of the analysis of the different ingredients included in the mixed fertilizer in terms of N, P and K.

Fertilizer ratio : This indicates the relative percentage of N, P_2O_5 and K_2O in the manure mixture.

Acidic fertilizer : Fertilizer capable of increasing the acidity of the soil by continued applications.

Basic fertilizer : Fertilizers which increase the pH and the soil on continued use by leaving a basic residue in the soil.

Neutral fertilizer : Materials which are neither increasing nor decreasing the pH of the soil

Filler : It is called as the ‘make-weight’ material added to the fertilizer mixtures. Filler materials are inert materials like sand, saw dust etc, are added to make up the difference between weight of ingredients added to supply the plant nutrients in a tonne and the final weight viz., 1,000 kg.

Advantages

All the three major plant nutrients are made available in one and the same material. There is saving of time and labour. The residual effects will not be there. The fertilizer mixtures are usually prepared taking into account the acidic or alkaline nature of the ingredients, and other chemical reactions. Hence, some of the residual effects like acidity

will not be there. Usually mixed fertilizer are prepared to suit a group of crops and soils.

Disadvantages

- Specific needs of crops and deficiency of individual nutrient elements cannot be satisfied by using mixed fertilizers as efficiently as in the case of straight fertilizers.
- The use of mixed fertilizer in such cases of specific needs will be a waste as other nutrients are also added to the soil.
- Unit cost of the various nutrients contained in the mixed fertilizer will always be higher when compared to the unity cost of nutrients contained in the straight fertilizers.

Improper mixing and storage of fertilizers can result in large nutrient losses. Some important aspects to consider in fertilizer mixing and storage include the following:

- Urea should not be mixed with ammonium calcium nitrate (CAN), KCl, SSP or TSP.
- Urea can be mixed with most other fertilizers but fertilizer mixtures containing urea should be applied immediately after mixing. Do not store fertilizer mixtures containing urea.
- Ammonium phosphates and super phosphates should not be mixed with lime, slag, rock phosphate or CAN.
- Potassium chloride and sulfate of potash can be mixed with most fertilizers, but mixtures of these fertilizers with urea and calcium ammonium nitrate should not be stored.
- CAN should not be mixed with basic slag but can be mixed with urea, single superphosphate, and ammonium phosphates immediately prior to application.

Do not store fertilizers in damp or dirty places. Make sure that bags of fertilizer in the store do not absorb moisture from leaky roofs or water seepage through walls and floors.

Preparation of mixed fertilizers

Many kinds of materials are used in the manufacture of fertilizer mixtures. The materials are found to be highly varying in their properties. However, only a limited number of materials are being used like $(NH_4)_2SO_4$, $CO(NH_2)_2$, Super phosphate, ammonium phosphate, muriate of potash, limestone, gypsum and some fillers.

The manufacture of fertilizer mixtures usually involves the weighing and proportioning of ingredients that are used, sieving and sizing of the various ingredients, mixing the different materials and packing. All the above operations are done both mechanically and by hand operation. Different kinds of machineries are being used.

Guide for mixing

To determine the amount of individual fertilizer in a mixture, the quantity is calculated as follows.

$$\text{Quantity} = \frac{\text{(Percentage of plant nutrient desired in the mixture) x (Weight of final mixture)}}{\text{(The Percentage of the plant nutrient in the straight fertilizer)}}$$

$$A = \frac{R \times T}{P}$$

R = Percentage in the mixture

T = Final weight of the mixture

P = Percentage in the straight fertilizer.

To prepare a mixture of 10: 5: 10 using $(NH_4)_2SO_4$, (20% N), Super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), the following quantities will be required per tonne (1,000 kg).

1. Ammonium sulphate $= \frac{10 \times 1000}{20} = 500$ Kg.

$$\frac{5 \times 1000}{}$$

2. Super phosphate $= \frac{}{16} = 312.5$ Kg.

3. Muriate of potash $= \frac{10 \times 1000}{60} = 166.5$ Kg.

Total = 979.0 Kg .

Filler = 1000 – 979 = 21 Kg.

If the total calculated weight exceeds the final weight, a mixture of that ratio can not be prepared.

Changes that occur while manufacturing mixed fertilizer

The ingredients used in fertilizer mixtures vary widely in their physical and chemical characteristics. When such widely varying materials in physical and chemical properties are mixed together, naturally many changes are expected to take place during or after the mixing. Some changes will be of physical nature and some will be of chemical nature. The following are the most important physical changes that will take place during or after the mixing of fertilizers.

Hygroscopicity

It is a property of any substance which absorbs from air and gets converted to semi- solid or liquid condition. Fertilizer like $Ca(NO_3)_2$, NH_4NO_3, $NaNO_3$ and $CO(NH_2)_2$ are capable of absorbing moisture from air and become hygroscopic. In such cases handling will be very difficult for such mixtures.

Caking up

Moisture present in some of the ingredients is responsible for caking up. Moisture dissolves some of the easily soluble ingredients and forms a saturated solution. This saturated solution on evaporation gives out crystals which knit together forming larger lumps.

The caking up can be prevented by the use of certain kind of materials called as ‘conditioners’. The commonly used conditioners are groundnut hulls, lime, clay etc. Another was of preventing the caking up is manufacture of granulated fertilizer mixture.

The granulation aims at preparation of uniform sized particles with reasonable stability, which presents caking up.

Segregation

This relates to separation of different sized particles individually. When ingredients of different sizes and densities are included there will be the tendency for the segregation (sorting out to different sizes) to take place. To prevent this bad effect, granulation is conveniently followed.

The following are some of the most important chemical changes that take place either during or after the manufacture of fertilizers mixtures. These changes are found to be influenced by temperature, moisture content and particle size of the in gradients.

(a) Double decomposition

The reaction is between two compounds without a common ion in the presence of moisture. New compounds are formed which may have different physical and chemical properties.

$Ca(H_2PO_4)_2 + (NH_4)_2SO_4 \longrightarrow CaSO_4 + 2\ NH_4\ H_2\ PO_4$

$NH_4\,NO_3 + KCl \longrightarrow NH_4\ Cl + KNO_3$

$(NH_4)_2\ SO_4 + 2\ KCl \longrightarrow 2\ NH_4\ Cl + K_2\ SO_4$

(b) Neutralization

This reaction takes place when free acids present in some of the fertilizers are neutralized by alkalis or Ca containing salts included in the mixture.

$H_2PO_4 + NH_3 \longrightarrow NH_4\ H_2\ PO_4$

$2H_3\,PO_4 + CaCO_3 \longrightarrow Ca\ (H_3\ PO_4)_2 + H_2CO_3$

(c) Hydration

The process of tying up of water by the anhydrous form of salts is called hydration. Some of the fertilizers are found to have this property.

$CaSO_4 + 2H_2O \longrightarrow CaSO_4\ .2\ H_2O$

$Ca\ HPO_4 + 2H_2\ O \longrightarrow CaHPO_4.\ 2\ H_2O$

(d) Decomposition

Under certain conditions of moisture and temperature, there will be break down in the composition of molecules forming new compounds.

$CO(NH_2)_2 + H_2\ O \longrightarrow 2\ NH_3 \uparrow + CO_2$

$(NH_4)_2\ HPO_4 \longrightarrow NH_4H_2\ PO_4 + NH_3$

However, the following important principles must be taken into consideration while preparing mixed fertilizers.

1. All fertilizers containing ammonia are not mixed directly with the basic fertilizers (e.g. RP, limestone, basic slag, $CaCN_2$) as reaction will take place resulting in the loss of gaseous NH_3.
2. The water – soluble phosphates are not mixed with those materials which contain free lime (e.g) lime stone, CaCN2) as there will be reaction towards the reversing of water – soluble phosphate to water – insoluble phosphates.
3. Hygroscopic fertilizers are not included as they will facilitate caking up.
4. The acidic fertilizers are likely to produce some free acids which may damage the container or packing materials.

Manufacturing process

The principal steps in the manufacture of solid mixed fertilizers are calculating, weighing, sieving, sizing, mixing the materials and packing the product.

Calculating and weighing

With a good weighing device the calculated quantities of the various ingredients are weighed accurately for preparing mixtures.

(1) Seiving and sizing

If the raw materials have undergone too much of caking in the storage piles, it may be necessary to subject them to preliminary grinding, sieving and sizing. The raw materials must be converted into uniform sized particles to have effective making and to avoid segregation during subsequent handling.

(2) Mixing

Many kinds of fertilizer mixing machines have been proposed and used at present. Rotary drum type is found to be more common than the vertical cylinder type. Weighed quantities of different materials are introduced into the mixer and mixed thoroughly.

(3) Packing

Equipments for packing fertilizer mixture range from the simplest types of hand operated facilities to highly sophisticated automatic machines.

Granular mixtures

Compared to pulverized or powdered mixture, the advantages of granular mixtures are reduced caking up tendency, less dusting loss and easy handling. Of late, attention is found in the manufacture of only granular mixtures.