Today we will look at the methods of application of liquid and carrier based biofertilizers. The outline of this session will include methods of preparation of liquid biofertilizer methods of preparation of carrier based biofertilizer and methods for their application.

At the end of this session, the students will know how to prepare the inoculum for the biofertilizer.

The different types of biofertilizer, the liquid biofertilizer carrier material, definition and types sterilization of carrier, properties of an ideal carrier, methods of mixing of the inoculum broth with the carrier, packaging and storing and methods of application of biofertilizer.

Let us look at the preparation of the inoculum. The broth Is prepared in flasks and the inoculum from other culture is transferred into the flask. The culture is grown under shaking conditions at 30 +/- 2 degrees as a submerged culture. So now this inocululum, which is our biofertilizer will be present in this liquid broth.

The culture is incubated until the cell proportion or the said population reaches about 10^9 10^{11} cells per ml depending on what is your inoculum.

It takes different periods of time for growing. For *Rhizobium.* it takes between 4 to 9 days and for *Azopirillum* it takes 5 to 7 days. Phosphobacteria take two to three days while *Azotobacter* take about 6 to 7 days for growing in broth.
Liquid biofertilizers are microbial preparations which contains specific beneficial microorganisms and these are present in a suitable medium so that they remain living or viable for certain amounts of time and when they are living, they are capable of fixing nitrogen or solubilizing or mobilizing different plant nutrients.
So we can classify liquid biofertilizers either as nitrogen fixing or as phosphorus solubilizing, or phosphorus mobilizing or as potash mobilizing microbes.

What are the components of a liquid biofertilizer?

So for the biofertilizer to be liquid they should have the desired microorganism. That means your inoculate the nutrients for these microorganisms to grow and enjoy a long shelf life and they can be tolerant to adverse conditions. And they should also have substances.To encourage the formation of resting spores or cysts so that they survive for a long time even after application, the consistency of the liquid biofertilizer can either be in the form of an aqueous broth or they can be as mineral or organic based oils. They can be an oil and water suspension or a polymer based suspension.

What are the carrier materials and what is a carrier material?

The carrier is a medium that carries the microorganism in sufficient quantities and it will keep the microorganisms viable under specified conditions so that it can be easily supplied to the farmer.

Different types of carrier materials are used, like peat, soil, lignite, vermiculite, charcoal, farmyard, manure,bagasse, etc.

Out of these neutralized peat, soil or lignite are better as carrier materials compared to the others.
How are these carrier materials produced? They are ground so that you get a fine powder which should pass through a mesh between 10 to 40 Micron size. The pH is also adjusted to make make it neutral by mixing with calcium carbonate if required. The carrier materials are sterilised so that the innoculant has a longer shelf life.

How are the carrier materials sterilized?
Two methods of sterilization. One is by using gamma radiation or by autoclaving.
Gamma radiation is better because it does not change the physical and chemical properties of the carrier material.

The carrier material is packed in thin polythene bags and about 50 kilorads of gamma irradiation is subjected. However, this method can be a little expensive. On the other hand, autoclaving the carrier material is stacked in partially opened thin wall polypropylene bags and autoclaving is done for one hour at 121 degrees Celsius. However, Autoclaving sometimes can change the properties of the carrier material and even produce toxic substances.

What are the properties of an ideal carrier and ideal carrier material?
It should be highly absorptive with more than 50% of water holding capacity.
It should be non toxic to plants and microorganisms.
It should be easy to sterilize, either by autoclaving or by gamma irradiation.
It should be available throughout the year and should be cheap, easy to process, free of lump forming materials,
It should have a good microporous structure.
It should also have a good buffering capacity and a high organic matter contained.
The carrier material should permit the survival of the inoculum during the storage period.
It should also permit the survival of the inoculum in the soil. It should have the ability to compete with native soil microorganisms for the nutrient and habitat niche to survive against grazing protozoa.

What are the carriers that are used for seed inoculation?
For preparation of seed inoculants, the carrier material needed is a fine powder with a particle size of about 10 to 40 Micron. Peat is the most frequently used carrier material when we have seed application.
Other carriers include industrial waste, composted sawdust, mineral soils, coal, soybean oil, or peanut oil added with life list cells.

When we want to inoculate soil, the carrier materials that are used for soil inoculation include granular forms of peat, perlite, alginate, Wheat bran sugar cane bagasse.

The granular inoculants are also amended with nutrients, charcoal or soil aggregates.

The next step, after we have chosen our carrier material, we have to mix the inoculum with the carrier material. Now inoculululum is in broth or carrier material has already been prepared.

They inoculate broth is mixed with the carrier material.
Depending on the density of the cells that carrier can hold,, they are to be diluted if required.

The culture suspension is added to a level of about 30 to 40% water holding capacity of the carrier material. Carrier and water are mixed, either manually or mechanically, and they're kept in trays fortwo to five days for curing.

The cells sound should reach 10^{9-10} cells at the time of curing,

Polythene bags are filled to a predetermined weight depending say for example, 200 grams or 500 grams etc and then they're electrically sealed and labeled.

What are the specifications of your packaging material?

The material should be made of polythene of low density.

They have to be opaque so that life doesn't pass through and about 50 - 70 Micron in thickness. There should be certain markings on the label of that packaging material. For example, name of the manufacturer, product names, strain number, crops for which you are recommending,
date of manufacture, batch number and expiry date. full address and storage instructions.

What is the storage for these biofertilizer at normal room temperature,
The inoculate can be stored for up to three months. The shelf life could be extended to 12 months if it's kept at 4 degrees. They inoculate package, should be stored in a cool place away from heat or away from direct sunlight. The packets are prepared by manual mixing.

They have a short shelf life, while packets which are prepared under complete sterile conditions have a longer shelf life of about 6 to 12 months.

What are the advantages of liquid biofertilizer over the conventional carrier based?

The liquid biofertilizers have a longer shelf life.There's no contamination, no loss of property because of

storage at up to 45 degrees. The organisms are stable during production, distribution and storage,

and the activities enhanced on contact and interaction with the target crop.

There's a greater potential to fight with native population whenit comes to liquid biofertilizer. They are easy to identify by a typical fermented smell.

So knowing this smell, then we know that the liquid biofertilizer is still living. Better survival on seeds and soil and liquid biofertilizers are more

]]tolerant to adverse conditions. They easy to handle and apply by the farmers.They can be used either as sprayers or power sprayers. There were high export potential and special cell protectors or substances that encourage formation of resting spores or cysts.

Ensure that they remain in soil for a long period of time. So their doses are ten times lesser than that of carrier based biofertilizers.
What are the methods of application of these liquid or carrier based biofertilizers ?
there are three ways either we trick the seed or we dip the root or we apply them to the soil when we're treating the seed seed treatment is the most common method. It can be done either with liquid or with a slurry of carrier based biofertilizer. It's carried out with rhizobia as a tobacco as Aspira, lumped together with phosphate solubilizing microorganisms.

You see, the application is done with two or more bacteria, than the seeds are first coated with a nitrogen fixing biofertilizers and after you've treated the seeds with the nitrogen fixingbiofertilizers then the outer covering or the outer layer is of the phosphate solubilizing bacteria mixing different types of bacteria and then applying them on the seat does not give the desired result, so it has to be done in steps or in stages for seed treatment or small quantity of seeds are. That have to be coated can be done in a plastic bag. The bag containing the biofertilizer isfilled with about 2 kilograms of seeds. The bag is closed so that there s a lot of air inside the bag. The bag is in squeezed for about 2 minutes until all the seeds are uniformly vetted. The bag is opened, inflated again and this process is is repeated again.

That means it is shaken so that the seeds are completely coated. Stop shaking after the seeds get a uniform layer of the culture. The bag is opened. Seeds that dried in the shade for 20 to 30 minutes.

The second method of application is root dipping for application of Azospirillum or phosphate solubilizing microorganisms on Paddy transplants or vegetable crops.

This method of root dipping is used the required quantity of Azospirillum or PSM is mixed with five to 10 liters of water in one corner of the field and the roots are dipped. At least half an hour before transplantation, the last method is soil application.

Soil application is used for phosphate solubilizing microorganisms.

The PSM, or the phosphate solubilizing microorganisms are mixed with cow dung, farmyard manure in half a bag of rock phosphate. These phosphate solubilizing microorganisms can now solubilize this rock phosphate and make it available for the plants.

This solution is kept in the shade overnight, at least with 50% of moisture. This mixture is used as a soil application in rose or during the leveling of the soil.

What are the precautions taken when we are using biofertilizers?

The first thing is this biofertilizers have to be stored properly away from sunlight. Rhizobium is host specific so it has to be used with the specified crop. Do not mix biofertilizers with chemical fertilizers. And they have to be used before the expiry date using the recommended method.
At the end of this session you should be able to answer these questions first.

List the ideal characters of a carrier material.
What are the methods of sterilization of carriers
What are the different approaches and application of biofertilizers?
What are liquid biofertilizers
State that types and components?

These are references.