Welcome Students', I am Dr. Kim Rodrigues, Assistant Professor in Department of Botany,
Carmel College of Arts, Science & Commerce for Women, Nuvem-Goa.
Today I will be teaching *Rhizobium* as Biofertilizer for third year B.Sc. Botany semester VI students.

Course Code: BOD 104
Course Title: Biofertilizers

Title of the Unit : Unit 2 - Symbiotic Nitrogen Fixing Microbes
Module Name : *Rhizobium* as Biofertilizer - II
Module Number: 05

The Module outline is:
Production of carrier-based inoculants
Techniques of field application
Crop response

The learning outcomes of the module are:
Describes the production of *Rhizobium* carrier-based inoculants
Explains the techniques of field application of *Rhizobium* carrier-based inoculants and its response on crops

In the previous module *Rhizobium* as Biofertilizer - I, we studied about the root nodule symbiosis; isolation, identification and mass multiplication of *Rhizobium*. In this module we are going to study the production of carrier-based inoculants of *Rhizobium*, techniques of field application of *Rhizobium* carrier-based inoculants and its response on crops.

***Rhizobium* as Biofertilizer**

Rhizobial biofertilizers can be carrier-based inoculant, agar-based inoculant, broth culture and dried culture
New developments in biofertilizer productions are:
Freeze-dried inoculants, *Rhizobium*-paste, granular inoculant, pelleting, polyacrylamide entrapped rhizobia and pre-coated seeds appear to be more promising for inoculation success in tropical legumes
Carrier-based inoculant has been regarded as most suitable for commercial purposes

Production of Carrier-Based Inoculants

A variety of carriers are used for rhizobial inoculants like peat, lignite, farmyard manure, charcoal powder, etc.
Carrier is powdered and dried in sun to get 5% moisture level

The carrier is then screened through mesh sieve and neutralised by mixing with calcium carbonate powder
It is sterilized by autoclaving at 15 PSI for 3 hours and dried
The harvested broth is mixed with carrier
The moisture content should be about 35-40% on dry weight
Carrier containing inoculant is left for 2-10 days at 22-24^{o}C. During this process *Rhizobium* multiplies. This is the curing process
Rhizobial count should be 3 x 10^{8} cells/g of carrier
Rhizobium inoculant can be used directly or packed and stored

Packing and storage

Cured carrier-based inoculants are packed in polythene bags and kept at a constant room temperature for about a week to facilitate the rhizobial cells to get established.
Bags should be stored at 4-15^{o}C in a cold room so that rhizobial cells may remain viable for more than 6 months.
Bags should not directly be exposed to sunlight or heat otherwise rhizobial cells will be killed.

Techniques of field application

Seed treatment/inoculation with carrier-based inoculant:
50 g cane sugar is dissolved in 500 ml water and boiled for 15 minutes
Followed by adding 200 g of gum arabic to the boiling solution and stir well, cool
This is the sticker solution
We then add 200 g of carrier-based *Rhizobium* inoculant into sticker solution, mix it well to get the biofertilizer slurry
We then add seeds of a legume into the slurry, mix well by hands. This results in about 10^{5}-10^{6} rhizobial cells get adsorbed on each seed
Dry the seeds by spreading on a polythene sheet in shade
Sow the seeds coated with rhizobial cells in the field

Pelleting:
When soil has adverse conditions such as dryness, acidity, excess fertilizers and pesticides, the rhizobial cells are protected by adopting a special method of inoculation i.e. pelleting or preparation of pelleted seeds.
This method is similar to seed treatment, but high amount of gum arabic i.e. 40% is added to the inoculum slurry and finally a pelleting agent such as calcium carbonate, rock phosphate, charcoal powder, gypsum, bentonite is mixed when inoculated seeds are moist before seed drying.

Sometimes the inoculum is stored at 4^{o}C. Stored inoculum is sprayed over the soil directly to improve the soil fertility.

Crop response

Seed inoculation of a proper *Rhizobium* strain increases growth and yield of many legumes.

Rhizobium usually increases the yield of legumes up to 10-35%.

In *Cajanus cajan*, it increases yields up to 4-40%.

In *Cicer arietinum*, it boosts the yield up to 4-67%.

In *Vigna mungo*, it increases the yield up to 4-29%.

In *Lens culinaris*, it improves the yield up to 21%.

Crop rotation of *Rhizobium* inoculated legumes with cereals increases the yield of the subsequent cereal crop.

Crop rotation of *Cajanus cajan* with *Triticum aestivum* increases the wheat yield up to 16.4%.

Crop rotation of *Lens culinaris* with *Oryza sativa* has increased the rice yield up to 13.2%.

Summary

To summarize:

Rhizobium biofertilizer in the form of carrier-based inoculant has been regarded as most suitable for commercial purposes.

A variety of carrier materials are used for rhizobial inoculants like peat, lignite, farmyard manure, charcoal powder, etc.

Good quality of carrier-based inoculant is that which contains sufficient amount of rhizobial cells i.e. 3 x 10^{8} cells/g of carrier.

Rhizobium as biofertilizer helps to improve soil fertility, plant nutrition and growth.

These are some of the references.

Thank you.