Seed-inoculation steps:

The following steps are recommended by the Ethiopian Institute of Agricultural Research (EIAR, 2003).

1. Step 1: Measure clean seed sufficient to be planted on the same day and transfer it to a container.

2. Step 2: Fill a 300 ml soda bottle with lukewarm water and transfer the water into 500 ml plastic bottle for easier mixing.

3. Step 3. Add two tablespoons of table sugar to the water and mix thoroughly to get an even solution of the sugar. The solution is called the sticker.

4. Step 4. Add some sticker to the weighed amount of seed to be planted that day. Mix until all the seeds are evenly coated with the sticker.

5. Step 5. Inspect the inner inoculant transparent bag for any fungal growth *(shagata)*. If there is no foreign growth, shake the entire contents very well until all clods are broken. Open the inoculant sachet under the shade and pour the recommended amount onto the moistened seeds

6. Step 6. Mix seed and inoculant by slowly shaking until all the seeds are uniformly coated. Be careful not to split the seeds or peel the outer coat by using excessive force.

7**. Step 7.** Cover or put inoculated seed in the shade, if necessary. Do not expose coated seeds to direct sunlight for a long time, or else the N-fixing bacteria will die before the seed is planted.

8. **Step 8**. Plant seeds immediately after inoculation. The seed needs to be covered in soil immediately and not exposed to harmful sunlight Mix and plant the next batch of seeds by repeating steps 1, 4 6, 7 and 8 until the whole field is planted.

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

Published by:
GIZ-SLM, P.O.BOX 100009, Addis Ababa, Ethiopia
In cooperation with the MoANR **(V130916)**

SUSTAINABLE LAND MANAGEMENT PROGRAM (SLMP)

Promotion of Rhizobium Inoculants

SLM ETHIOPIA

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by giz

Introduction

Depletion of soil fertility is one of the root causes of declining food production in small holder farmers in Ethiopia, and hence soil fertility replenishment should be considered as a strategic investment in natural resource management.

Nitrogen is an essential element for all living organisms. It is a key component of proteins. Nitrogen depletion results from crop removal and erosion. The nitrogen reserve of agricultural soils must be replenished regularly in order to maintain crop production. Replacement of soil nitrogen is accomplished by the addition of inorganic fertilizers and by biological nitrogen fixation.

Mineral nitrogen fertilizers are produced industrially by chemically fixing N2 gas from the air to produce ammonia. This process is energy consuming and expensive.

Alternatively, nitrogen fixation occurs through the normal metabolic activity of bacteria, a process commonly referred to as biological nitrogen fixation (BNF). Bacteria, either free living or symbiotic are able to convert atmospheric nitrogen to biologically useful forms. However, only symbiotic bacteria in the root nodules of legumes are able to fix significant amounts of atmospheric nitrogen. Legumes are the most important plants which can make symbiotic relationship with rhizobium bacteria by forming root nodules.

BNF in the rhizobium-legume symbiosis offers an inexpensive alternative for smallholder farmers to mineral fertilizers and its benefits can extend to subsequent crops as residual sources of organic nitrogen in crop residues, roots and nodules.

Although Rhizobium is a common inhabitant of agricultural soils, its population is often insufficient to achieve a beneficial relationship with the legume. When there are no native rhizobia in sufficient quantities for N2 fixing, it is necessary to inoculate the seed before planting to ensure the biological fixation of N2.

Rhizobia inoculants are selected strains of beneficial soil micro-organisms cultured in a laboratory and packed usually with a carrier. They are host-specific, low cost and an environmentally friendly source of nitrogen.

Inoculation is defined as the addition of effective rhizobia to leguminous seeds prior to planting for the purpose of promoting symbiotic nitrogen-fixation. Rhizobia inoculants coated on legume seeds before planting enhance the growth and yield of legume crops and provide nitrogen and organic carbon for subsequent or associated crops.

When is it necessary to Inoculate?

Inoculation is recommended when the field has no past history of growth of a particular legume. Rhizobium Inoculant can remain viable in the soil without the presence of a legume for a number of years, and then be ready to form nodules when its host plant is sown. Specifically, inoculation is recommended if the field has been out of host plant production for 3–5 years, or has never been planted to the host.

Further, inoculation can help increase rhizobia populations in fields with unfavorable environmental conditions for the bacteria's long-term survival, such as when the pH is below 6.0, in extremely sandy or highly degraded soils with low organic matter content, and where soils are periodically-flooded. Generally, inoculation is necessary in the majority of agricultural soils throughout the world.

Commercially available Rhizobia inoculants

Table below shows commercially available Rhizobia inoculant species in Ethiopia

Type of inoculant (Rhizobia)	Crop
Rhizobium leguminosaru vicae	Faba bean/Field pea
Mesorhizobium cicer	Chick pea
Bradyrhizobium japonicum	Soybean
Rhizobium leguminosarum	Lentil
Ensifer meliloti	Alfalfa
Rhizobium leguminosarum phaseoli	Common bean
Bradyrhizobium elkanii	Cowpea
Rhizobium spp	Groundnut

Seed inoculation

Users should inoculate only the amount of seed that can be planted that same day. Use the information in Table below to calculate the amount of inoculants to be used on the seed that is going to be planted that day, taking into account the labour force that will be available. When planting inoculated seeds, they should be covered immediately with soil to protect the seeds from the damaging effects of sunlight.

Amount of inoculant (gram)	Quantity of seeds (kg) and area coverage (ha)					
	Faba bean*		Soybean*		Lentil*	
	Seed rate (kg)	Area (ha)	Seed rate (kg)	Area (ha)	Seed rate (kg)	Area (ha)
125	18	0.125	20	0.25	21	0.25
250	36	0.25	40	0.5	42	0.5
500	72	0.5	80	1	84	1

* The above three legumes represent larger (faba bean), medium (soybean) and smaller (lentil) seed size. Source: Ethiopian Institute of Agricultural Research, 2003

Inoculants can be obtained from:

Ministry of Agriculture
National Soils Research Canter
P.O.Box 147
Tel: 0115508300/1
Addis Ababa

Or

Menagesha Biotech
Dr. Asfaw Hailemariam
Mobile: 0911411318,
email:**asfawhailemariam@yahoo.com: asfawhailemariam@gmail.com**