Effect of Lactobacillus Inoculants, Organic Amendments and Mineral Elements on Yield of Onion and Field Bean

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Background

Bacteria of the genus *Lactobacillus* are often characterized as zymogenic microorganisms, i.e., those which are able to ferment carbohydrates into lactic acid. *Lactobacillus* spp. are often found in commercially-available microbial inoculants that are reported to have beneficial effects on the growth and yield of crop plants (Higa and Parr, 1994). According to Higa (1991) there is a high level of zymogenic activity in freshly-plowed soils, much of it due to *Lactobacillus* spp. Other zymogenic microorganisms include yeasts which are responsible for fermentation of sugars into alcohol. It is important to realize that most zymogenic microorganisms produce extracellular enzymes which ferment substrates outside their cells. Consequently, if conditions are favorable, these fermentative enzymes are capable of inducing substrate fermentation long after the organism it-self has "died-away" (i.e., no longer detectable). An important consideration here is the residual zymogenic enzyme activity and not necessarily the number of zymogenic microorganisms that are present at a particular point in time (Primavesi, 1987). Nevertheless, most *Lactobacillus* inoculants contain large populations of lactic acid bacteria as well as a high level of enzymatic activity. Proper soil management practices are vital to maintain a high level of zymogenic activity (Primavesi, 1990).

In view of these observations, three *Lactobacillus* inoculants were evaluated in a field plot study to determine their effects on the growth and yield of bean and onion crops. Bean seed and onion seedlings were treated with Agroplus, EM (i.e., Effective Microorganisms), and RG (Supermagro) prior to planting. The plants were then sprayed three times at eight-day intervals with the inoculants diluted in water to specific concentrations. Other treatments included Skrill (a mineral supplement derived from evaporated sea water) applied to seeds and leaves; Fosmag (a mineral fertilizer supplement) applied to soil; and three organic amendments including Bokashi (fermented organic matter) applied to soil; green manure applied to bean plots; and maize stubble mixed with weeds applied to the onion plots. In the bean study, both EM and Skrill were applied in combination with Fosmag and Bokashi.

Materials and Methods

Randomized and replicated field plot experiments were conducted to determine the effect of Lactobacillus inoculants, organic amendments and mineral supplements on the growth and yield of bean and onion crops.

Composition of the lactobacillus Inoculants

Agroplus:

Agroplus consists of an aqueous mixture of soybean meal, molasses and milk. It also contains mixed cultures of *Lactobacillus* spp., *Nitrobacter* spp. and yeasts. Milk is added to enhance the growth and activity of lactic acid bacteria. The product is formulated by aerobic fermentation.

Effective Microorganisms (EM):

EM consists mainly of lactic acid bacteria, photosynthetic bacteria, yeasts and actinomycetes, along with other genera and species of beneficial microorganisms. The inoculant is formulated by anaerobic fermentation with molasses as a carbon and energy source. It is diluted with water prior to use.

RG or Supermagro:

RG consists of fresh farmyard manure (FYM), fresh milk and a nutrient mixture (Ca, Mg, Fe, Cu, Zn, B, Mo, Co) diluted with water and formulated by aerobic fermentation. Milk is added to enhance the growth and activity of lactic acid bacteria.

Composition of the Nutrient Sources

Skrill:

This is a commercially-available product derived from evaporated sea water and consists mainly of Na, Cl, Ca, Mg, K and other mineral elements in smaller amounts.

Fosmag :

This is a commercially-available product often applied to soil as a fertilizer supplement. It consists of P 14%, Ca 13%, K 10%, S 8%, Mg 3% and Zn 0.6%.

Bokashi:

Bokashi is a biofertilizer and soil conditioner produced from carbonaceous (e.g., rice bran and rice hulls) and nitrogenous (e.g., fish meal and blood meal) organic materials, often mixed with water and molasses, and formulated by anaerobic fermentation.

Experiment 1

This experiment was conducted on a marginal soil, i.e., sandy texture, low fertility and low productivity. Field bean (var. Carioquinha) was planted in replicated plots after soil and seed treatment. The three Lactobacillus inoculants, including Skrill, were initially applied to seeds and then to leaves at 8, 16 and 24 days after emergence. The products were diluted with water and applied to leaves at the following concentrations: Agroplus 1.0%, EM 0.02%, RG (or Supermagro) 0.5%, and Skrill 1.5%. All plots except the control received a basal application of green manure. Fosmag was applied at a rate of 200 kg ha^{-1}. Treatments applied are as follows:

- Control (no amendments, chemical or non chemical).
- Green manure only.
- Fosmag on soil.
- Skrill on seeds/leaves.
- Skrill on seeds/leaves; Fosmag on soil.
- Skrill on seeds/leaves; Bokashi on soil.
- EM on seeds/leaves.
- EM on seeds/leaves; Fosmag on soil.
- EM on seeds/leaves; Bokashi on soil.
- Agroplus on seeds/leaves.
- RG on seeds/leaves.

Experiment 2

This experiment was conducted in two blocks. In one block, plots were fertilized with Fosmag at 200 kg ha^{-1} while the second block received no mineral amendments or nutrients. Except for the control, plots in both blocks received an organic amendment (maize stubble and weeds) at a rate of 8,000 kg ha^{-1}. Plot size was 1x3 m. Onion seedlings (i.e., slips or sets-var. Bahia) were transplanted in rows with plants 20 cm apart and 18 cm between the rows. Treatments applied to both blocks are as follows:

- Control (no amendments, chemical or non chemical).
- Skrill (1.5%) spray-applied.
- EM (0.02%) spray-applied.
- Agroplus (2.5%) spray-applied.
- RG (0.5%) spray-applied.

All formulations were foliar-applied at 8, 16 and 24 days after transplanting.

Results

Experiment 1

The highest field bean yields were obtained with EM (2087 kg ha^{-1}) and RG (1780 kg ha^{-1}) with somewhat lower yields for Skrill and Agroplus. Bean yield for green manure alone was approximately double that of the untreated control (i.e., no organic amendment applied). Yields for EM, Skrill and Fosmag, each with green manure, were 68, 44 and 15 percent higher, respectively,

compared with green manure alone. The lack of response to Fosmag was surprising in view of the low fertility status of the soil. Bokashi had little effect on yield which may indicate the need for additional time to exert its benefits. It appears that EM plus green manure would be the most expedient means of maximizing bean yields on this particular soil. Moreover, it is noteworthy that the average bean yield in this region from conventional (i.e., chemical) farming is about 1,800 kg ha^{-1} which requires inputs of NPK (2,000 kg ha^{-1}), urea (500 kg ha^{-1}), and various pesticides (usually four applications). Thus, the EM plus green manure treatment would incur significantly lower costs and higher net returns than the chemical-based farming system.

Experiment 2

Unlike the bean experiment, Fosmag increased onion bulb size for all treatments applied alone including the control (Table 1). Bulb size for Fosmag alone was approximately double that of the untreated control (i.e., no Fosmag). In the treatments without Fosmag, all three inoculants and Skrill resulted in onion bulb sizes that were at least double that of the control. The greatest increase in bulb size occurred with Skrill alone where bulbs were 132 percent larger than the untreated control. With Fosmag, the bulb size increased significantly for all treatments compared with no Fosmag (i.e., control 81%; Skrill 26%; EM 98%; Agroplus 35%; and RG 39%).

Table 1. Effect of *Lactobacillus* Inoculants and Mineral Amendments on the Size of Onion Bulbs in a Field Experiment.

Treatments	With Fosmag (g/bulb)	Without Fosmag (g/bulb)
Control	105	58
Skrill	170	135
EM	210	106
Agroplus	162	120
RG	178	128

Conclusions

Field bean yields were highest for EM applied with green manure compared with all other treatments. Yields were lower with the mineral amendments which was surprising because of the low soil fertility status involved. Bean yields obtained for EM and RG applied with green manure were comparable to those for conventional farming systems receiving chemical fertilizers and pesticides. However, the cost for the EM plus green manure treatment was lower and net returns were higher compared with the chemical-based system. Onion bulb size obtained with EM and Fosmag were higher compared with all other treatments. Onion yields were comparable to the conventional, chemical-based system. Again, production costs with EM were lower and net returns were higher compared with the conventional, chemical-based farming systems.

References

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