Large Scale Validation of an AM Fungal-Based Biofertilizer and its Management with Rhizobium for Bean Production, in Central and Western Cuba

R. Rivera[1], A. Calderón[1], María C. Nápoles[1], L. Ruiz[2], Chantal Hamel[3] and collaborators
[1]National Institute of Agricultural Science (INCA); [2] Institute of Tropical Roots and Tubercles;
[3] Semiarid Prairie Agricultural Research Centre, Swift Current AAFC.

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Abstract

Fourty workshops were given to teach farmers how to improve fertilizer use efficiency in bean through the use of biofertilizers. Experiments were set up in 50 fields on commercial farms. Two treatments were applied in all fields: coating of bean seeds with an inoculant of arbuscular mycorrhizal fungi (EcoMic®) and a non-inoculated control. In 15 fields, a third treatment, EcoMic ® plus a rhizobial inoculant with a nodulation enhancement factor (Azofert®), was applied. All field received half the recommended rate of N-P-K. The effect of EcoMic® was positive in all fields. Yield increase ranged between 0.2 and 0.4 t ha^{-1}. The combined application of EcoMic ® and Azofert® yield was additive and averaged about 0.58 t ha^{-1}, an increment corresponding to 52.5% yield increase.

Introduction

Since the dissolution of USSR in 1991, Cuba brought to fruition much research efforts in the development of biotechnologies for improving the efficiency of nutrient use by crop plants. In particular, Cuban scientists conducted important research on the improvement of symbioses in crops using inoculants of arbuscular mycorrhizal fungi (AMF) and rhizobial bacteria, which are well known beneficial soil microorganisms. They developed improved rhizobial inoculants for agriculture, and were introducing AMF inoculants in Cuban cropping systems through this work. EcoMic® is a mycorrhizal biofertilizer formulated for seed coating that is used to improve the efficiency of nutrients and water use by crops. Research results predict yield increase ranging between 10 and 40% with the use of EcoMic®.

Azofert® is a new biofertilizer containing rhizobial bacteria and nodulation inducing factors increasing the effectiveness of the inoculant. Bean is an important food crop with high value on international markets. Thus, reducing the cost of bean production with environmentally sound technologies will be highly rewarding.

The objective of this work were to (1) evaluate the feasibility of applying EcoMic® and Azofert® in bean production, (2) evaluate the economic impact of these biofertilizers at farm scale, and (3) provide training to farmers on the use of these products.

Methods

The project involved 50 fields of 2 to 36 ha distributed in five provinces in western and central Cuba, in the season 2010-2011 and 2011-2012. Fourty workshops were given to instruct farmers. Bean crops were grown on Calcaric Cambisols, Eutric Rhodic Nitisols, and Haplic Cambisols. In all fields, the value of EcoMic® was tested by comparing the effects of a control or seed coating with EcoMic®. A third inoculation treatment, EcoMic® + Azofert®, was applied on 15 fields in 2011-2012.

All fields received half the recommended rates of NPK (i.e., 300 to 400 kg ha^{-1} of 9-13-17 at seeding + 50 kg urea ha^{-1} after 35 days) and the plant growth stimulant FitoMas® (at the rate of 2 L ha^{-1} 15–20 days after seeding and just before flowering, i.e., 35-40 days after seeding). FitoMas® is a stress-mitigating extract from sugarcane produced by the Instituto Cubano de Investigación de los Derivados de la Caña de Azucar (ICIDCA).

EcoMic® was produced at the Instituto Nacional de Ciencias Agricolas (INCA) (Fernández et al., 1999). It contained 20 AMF spores g^{-1} and was applied at a rate of 4 kg ha^{-1}. The AMF strain *Glomus cubense,* which is appropriate for soils of medium fertility level (Rivera et al., 2007) was used everywhere except in 2010-2011 in the Calcaric Cambisols of VillaClara, where *G. intraradices* was proven effective in earlier trials (Rivera et al., 2007). Azofert® was produced at INCA, as described in Nápoles et al. (2010). Azofert® was seed coated with EcoMic®.

Conclusions

Glomus cubense performed better in the Rhodic Eutric Nitisols of Matanzas and C. Avila, and *G. intraradices,* in the Calcaric Cambisol (VillaClara). However, the effect of EcoMic ® was always positive. Yield increase ranged between 0.2 and 0.4 t ha^{-1}. The effects of combined application of EcoMic ® and Azofert ® on yield were additive and averaged about 0.58 t ha^{-1}, an increment corresponding to 52.5% yield increase.

References:

Fernández, F. et al., Metodología de recubrimiento de semillas con inoculo micorrizógeno. OCPI No Certificado 22641, 1999.

Nápoles, M. C. et. al., Medio de cultivo para *Bradyrhizobium japonicum* que induce la síntesis de los factores de nodulación. Patente OCPI. No. Certificado. 22797 (2002).

Rivera R. et al., Advances in the management of effective arbuscular mycorrhizal symbiosis in tropical ecosystesm. In: Mycorrhizae in Crop Production (eds.) Chantal Hamel and Christian Plenchette. Haworth Press, Binghamton, NY. 2007, p. 151-196.

Fig. 1 Manual application of EcoMic ® and Azofert® on-farm.

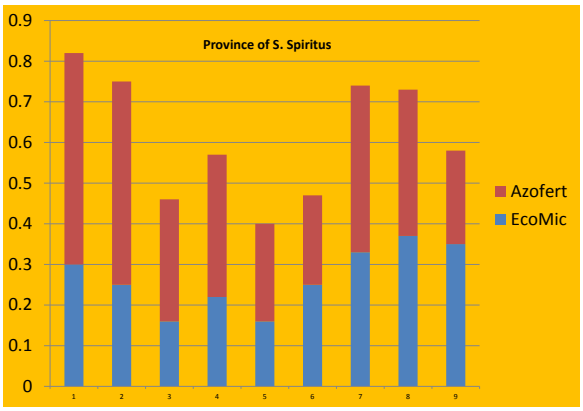

Fig. 3 Average yield increase (t ha^{-1}) from the use of EcoMic® and Azofert® in the provinde of S. Spiritus in 2011-2012.

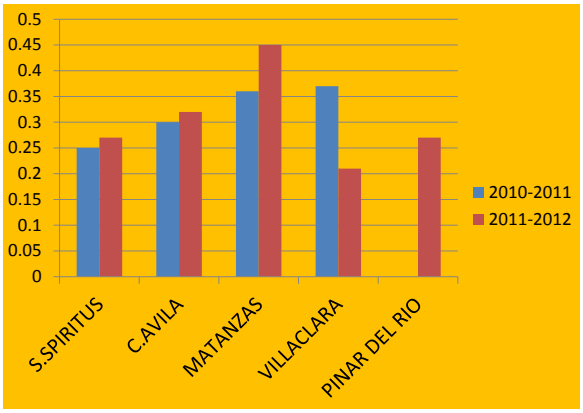

Fig. 2 Average yield increase (t ha^{-1}) from the use of EcoMic®, per province and year.

Fig. 4 60-day old bean field inoculated with EcoMic® + Azofert®, and receiving half the recommended rate of NPK plus FitoMas®.