Agricultural and forestry extension in biostimulants and bioinputs in Costa Rica: a short review

Extensión agrícola y forestal en bioestimulantes y bioinsumos en Costa Rica: una breve reseña

DOI: 10.34188/bjaerv4n4-032

Recebimento dos originais: 20/08/2021
Aceitação para publicação: 25/09/2021

Ricardo O. Russo
Ph.D. (Forestry), Yale University; M.Sc. Natural Resources, University of Costa Rica.
Institution: University of Costa Rica, Alfredo Volio Mata Experiment Station
Address: El Alto, Ochomogo, Costa Rica
E-mail: ricardo.russo@ucr.ac.cr

Graeme P. Berlyn
Ph.D. (Botany Forestry) Iowa State University, E.H. Harriman Professor of Forest Management and Physiology of Trees, Yale University, School of the Environment
Institution: Yale University, School of the Environment, New Haven, CT, USA
Address. 470 Prospect St., New Haven, CT 06511, USA

ABSTRACT
The use of biostimulants and bioinputs, including biofertilizers, biopesticides and microorganisms for agricultural use, has been developed considerably in the last three decades. Definitions for biostimulants vary greatly and there are still some arguments surrounding these compounds. However, they are defined as non-hormonal products which have a beneficial effect on plant growth. Many of these biostimulant materials are natural products that contain no added chemicals or synthetic plant growth regulators. Agricultural and forestry extension in biostimulants and bioinputs in Costa Rica has been a process towards sustainability.

Keywords: Costa Rica; biostimulants; bioinputs; agricultural extension; forestry extension.

RESUMEN
El uso de bioestimulantes y bioinsumos, incluidos biofertilizantes, bioplaguicidas y microorganismos para uso agrícola, se ha desarrollado considerablemente en las últimas tres décadas. Las definiciones de bioestimulantes varían mucho y todavía existen algunos argumentos en torno a estos compuestos. Sin embargo, se definen como productos no hormonales que tienen un efecto beneficioso sobre el crecimiento de las plantas. Muchos de estos materiales bioestimulantes son productos naturales que no contienen sustancias químicas añadidas ni reguladores sintéticos del crecimiento de las plantas. La extensión agrícola y forestal en bioestimulantes y bioinsumos en Costa Rica ha sido un proceso hacia la sostenibilidad.

Palabras clave: Costa Rica; bioestimulantes; bioinsumos; extensión agrícola; extensión forestal.
1 INITIAL CONSIDERATIONS

The use of biostimulants and bioinputs, including biofertilizers, biopesticides and microorganisms for agricultural use, has been developed considerably in the last three decades.

Definitions for biostimulants vary greatly and there are still some arguments surrounding these compounds. However, they are defined as non-hormonal products which have a beneficial effect on plant growth. Many of these biostimulant materials are natural products that contain no added chemicals or synthetic plant growth regulators. Although, du Jardin (2015) in his comprehensive and well-documented review states that “the word biostimulant was apparently coined by horticulture specialists for describing substances promoting plant growth without being nutrients, soil improvers, or pesticides”; and that “the first definition of the word biostimulants identifies a web journal dedicated to turf maintenance professionals, called ground maintenance (http://grounds-mag.com)” in 1997, and despite Zhang and Schmidt (2000), from the department of crop and soil environmental sciences of the Virginia Polytechnic Institute and State University, defined biostimulants as ‘materials that, in minute quantities, promote plant growth’, the concept was previously develop by Graeme Berlyn in his course on tree physiology, at Yale School of Forestry and Environmental Studies, in the 1980s and 90s (Berlyn & Beck, 1980, Berlyn, Beck & Renfroe, 1986, Berlyn & Russo, 1990a, 1990b, Russo & Berlyn. 1989, 1990, 1992a, 1992b, Russo, Poincelot & Berlyn, 1994). The goal of the previous statements is not to argue but to recognize Professor Berlyn's role in developing the concept.

2 AGRICULTURAL AND FORESTRY EXTENSION IN COSTA RICA

Some authors refer to agrarian, agricultural, or rural extension, also called extensionism, as a dynamic link between scientific research and agricultural production (Engel, 2000); others interpret it as a democratization of knowledge and its applications practices in the daily life of the people (Cano Gallego, 2004); while FAO defines it as a function and also as a knowledge system that promotes its use for the development of human beings, their communities and societies (Qamar, 2005). A conceptual framework to systemically analyze the dynamics and historical development of rural extension was presented by Alemanye (2011), who made a historical-critical analysis of theoretical and practical experience of extension practices. It demarks a space of five dimensions: (1) social development paradigm, (2) theoretical perspectives, (3) rural extension approaches, (4) extension systems and (5) extension practice. It is important to remark that agricultural extension works with rural people; however, agricultural research is conducted both by private sector firms supplying inputs to farm producers and by public sector experiment stations, universities and other research organizations.
The conventional agricultural and forestry production activity uses agrochemicals in abundance for the nutritional needs of crops and animals. These inputs have a high cost, and most of them are imported. In addition, the indiscriminate use of inorganic chemical fertilizers causes nutrient imbalance, loss of soil fertility and environmental impact. Furthermore, over the past thirty years Costa Rica has been a significant importer of agrochemicals in the world, and an extensive user of agrochemicals. This is one factor underlying soil degradation and unsustainable crop productivity (OECD, 2017).

Organic production in Costa Rica emerged in the early 1980s, starting with the organization of co-operatives of small-scale vegetable farmers. In the late 1990s, several important organizations were founded to promote organic production, including the National Association of Organic Agriculture (ANAO) and the National Program of Organic Agriculture (PNAO). The first law on organic agriculture was passed in 1995. More recent laws include the Phytosanitary Protection Law in 1997 and the Law on Encouragement of Organic Agriculture in 2007 (Law No. 8591). In general terms, the agricultural policies that promote the organic agriculture include financial and tax incentives; free inspections, certifications and training; articulation of public-private efforts to facilitate research, credit and training for producers; and consumption promotion of organic products (OECD, 2017). Nowadays it is required to carry out a more environmentally friendly agricultural activity, and at the same time allow increased food production.

3 CURRENT AND CONCEPTUAL SITUATION ON THE EXTENSION IN BIOINPUTS AND BIOSTIMULANTS

The agricultural extension on the use of bioinputs, including plant biostimulants, biofertilizers, biopesticides and microorganisms for agricultural use, has intensified in the last decade with the active participation of the Ministry of Agriculture and Husbandry (MAG) that has generated extension materials and support for small farmers, which includes guides for the preparation and application of bioinputs, visits and technical talks on farms, with monitoring and participation of the producing population, mainly in the central region of the country. This work is a contribution of agricultural extension to mitigation and adaptation to climate change. The use of bioinputs and biostimulants is closely related to organic agriculture and in Costa Rica, the initial milestone is located in the Zarcero region, which has more than 30 years of experience in managing organic agriculture in the country. More recently, the Direction of Accreditation and Registration in Organic Agriculture was created in 2004, on the initiative of the Educational Corporation for Costa Rican Development (CEDECO). In this whole process of interweaving between organic agriculture and biostimulants, the Japanese cooperation (JICA) played an important role with the coming of
Masaki Shintani and other Japanese cooperators, who introduced the technology of effective microorganisms (EM), later known as mountain microorganisms (MM) in the agricultural extension processes. Also, in 1995-96, the School of Agriculture of the Humid Tropical Region (EARTH University) adopted the EM/MM technology and humic substances research; and began commercial production and extension of both (EM® and Ecohum) through its students and graduates in Costa Rica and other countries of Latin America. Given that effective microorganisms play such an important role in the production of bioinputs, it should be remembered that in general it is a liquid cocktail that contains a set of beneficial microorganisms of natural origin; among which may be present: photosynthetic or phototropic bacteria, which is a group of autotrophic bacteria that synthesize useful substances from the secretions of the roots and organic matter, using sunlight and heat from the soil as energy sources (cyanobacteria, green sulfurous bacteria, violet sulfurous and non-sulfurous bacteria and Rhodopseudomonas spp., among others); lactic acid bacteria (Lactobacillus spp.), which produce lactic acid from sugars and other carbohydrates developed by other microorganisms; actinomycetes or actinobacteria, which are a category of gram positive filamentous bacteria and play an essential ecological role in decomposition of organic matter and in the formation of humic substances; yeasts, microscopic unicellular fungi capable of decomposing organic matter through fermentation, especially carbohydrates or sugars; fermentation fungi, such as aspergillus and penicillium, which are capable of rapidly decomposing organic matter, producing esters, alcohol and antimicrobial substances; and mycorrhizal fungi (Allahverdiyev et al. 2011, Higa, 1994, Higa and Parr, 1994).

While bioinputs are products of biological origin formulated with microorganisms (eg bacteria, fungi, viruses) or with microbial bioactive compounds, which are used to improve the productivity, quality and health of plants, or the biological characteristics of the soil. To formulate a bio-input, the microbial strains or metabolites are selected for their ability to promote plant growth: directly facilitating the absorption of nutrients by the plant or indirectly contributing to the sanitary management of diseases and pests of economic impact. Biofertilizers and biocontrollers are included as bio-inputs, although products with alternative names such as inoculants, rhizobia and other nitrogen-fixing microorganisms, mycorrhizae, microbial biological control agents and biopesticides, among others, are also considered (Altieri et al. 2012). It is accepted that a biofertilizer is a bio-input made from strains of beneficial microorganisms that applied to seeds or soil, promotes the growth of plants, or improves the use of nutrients. While a biocontroller is a bio-input made from strains of beneficial microorganisms or plant extracts that could improve the plant's health status by inhibiting plant pathogens or insect pests by antagonism, antibiosis, or other mechanisms.
Biostimulants as previously defined are non-inorganic fertilizing products that have a beneficial effect on the growth and development of plants in very low concentrations. Many of these biostimulant materials are natural products that do not contain agrochemicals or growth regulators; these compounds increase the growth and vigor of crops mainly because they increase the efficiency of absorption of water and nutrients and in some way, they copy the action of certain growth regulators (Berlyn and Russo, 1990a, 1990b, Russo and Berlyn, 1990, Bulgari et al. 2015). All this makes plants more resistant to adverse conditions such as water, caloric or nutritional stress, in addition to pests or diseases.

Organic seals: The experience of extension in bio-inputs in the Eastern Central Region of Costa Rica, has been developed by Rolando Tencio (extensionist), who has trained more than 300 producers in various bio-input techniques, after having been trained in Japan in 2012. Most of the extension agents in this region have already been updated by Mr. Tencio, and today they carry out training for producer groups. The farmers who make and use them have managed to reduce their production costs by more than 50%. Sustainable farms have increased in this region (there are more than 100 sustainable integral farms), as well as farms that are in the process of Ecological Blue Flag (Bandera Azul Ecológica), an on-farm sustainability award, with 290 farms registered for the year 2019 at country level (PBAE, 2018).

Several publications have been written such as: a technical guide for bio-inputs and several brochures and leaflets on the use of beneficial microorganisms and bioinputs in organic agriculture. In 2015, four students from WPI University (Polytechnic Institute of Worcester, USA) carried out an evaluation of the training and implementation of bio-inputs, with very positive results, leaving a written report as well as a 6-minute video with opinions from farmers (Castellano et al., 2015).

4 FINAL CONSIDERATIONS

The Agricultural and Forestry Extension in Biostimulants and Bioinputs has taken place in Costa Rica, in a non-articulated way, for three decades, but conceptually concurrent. We believe that this paper reflects in some way a clear link between the Agricultural Extension with the thematic axis that concerns us and that could contribute to the daily work of extensionists interested in organic agriculture and its related aspects. The experiences that have occurred (lessons learned) contribute to collective learning and lead to reflections, criticisms, comments, and proposals to improve the methodology, techniques and extension strategies in bioinputs and biostimulants necessary for organic production.
REFERENCES


