

## Biopesticides and Biofertilizers: Ecofriendly Sources for Sustainable Agriculture

Nagappan Raja\*

\*Department of Biology, Faculty of Natural and Computational Sciences, University of Gondar, Ethiopia

Agriculture sector plays an important role to improve the economic growth of developing countries apart from fulfilling the food security of the growing population globally. About one billion people lack access to adequate food and nutrition worldwide. The expected agricultural production has to be doubled so as to cater the needs of estimated 9 billion people during 2050. Presently, more than 870 million people are chronically hungry, many of whom are small farmers. In this juncture agricultural production is facing increasing challenges like water scarcity, climate change and volatility, raising the risk of production shortfalls. Since agriculture has potential for food security, environmental sustainability and economic opportunity worldwide, the future vision of the world is to adopt new strategies to increase agricultural production sustainably.

The Green Revolution (GR) technology adoption between 1960 to 2000 has increased wide varieties of agricultural crop yield per hectare which increased 12-13% food supply in developing countries. Southeast Asia and India were the first developing countries to show the impact of the GR on varieties of rice yields. Similar yield trends were observed for wheat and maize in Asia. In later days, crop genetic improvement focused mostly on producing high-yielding varieties, which resulted in early maturity in many crops allowing for an increase in cropping intensity. Other improved inputs, including fertilizer, irrigation, and to a certain extent, pesticides, were also critical components of the GR intervention. Poverty and food insecurity persisted despite the GR success.

In Asia, it has been estimated that each 1% increase in crop productivity reduces the number of poor people by 0.48%. The poverty still remains high in unfavorable areas like in poorest rain fed agriculture and marginal production environments as the GR was concentrated only in favorable areas where also yield growth was slowdown since the mid-1980s. During these periods of GR utilization of chemical pesticides and fertilizers to improve the agricultural productivity has caused detrimental impact on environment by affecting soil fertility, water hardness, development of insect resistance; increase the toxic residue through food chain and animal feed. The current trends in developed and developing countries in food habits among people are focused towards organic agricultural produces. Hence, it has become indispensable to harness the best of scientific knowledge and a technological breakthrough which are crucial to meet today's complex challenges. Biofertilizers and biopesticides are important areas to fulfill the challenges in a sustainable way.

Biopesticides are derived from natural materials such as animals, plants, bacteria, and certain minerals widely used for controlling insects and disease causing pathogens. As of early 2013 there are approximately 400 registered biopesticide active ingredients and over 1250 actively registered biopesticide products. The biopesticides are categorized under microbial pesticides, plant-incorporated-protectants and biochemical pesticides, which are produced through naturally occurring substances that control pests by non-toxic mechanisms. Biopesticides are usually inherently less toxic; generally affect only the target pest, effective in very small quantities, easily biodegradable, thereby resulting in lower exposures and largely avoiding the pollution

problems. When used as a component of Integrated Pest Management programs, it can greatly control major pest menace while crop yields remain high.

Increasing demand for residue free crop protection products is expected to boost the demand for biopesticides in near future globally. Growths in organic food market are other driving factors for increasing trend in global biopesticides market, since future organic industry is solely dependent upon the chemical free crop protection products to safeguard crops. The global biopesticide market was valued at \$1.3 billion in 2011 and is expected to reach \$3.2 billion by 2017. North America dominated the global biopesticide market, contributing for around 40% of the global biopesticide demand in 2011. Europe is expected to be the fastest growing market in the near future owing to the stringent regulations for pesticides and increasing demand from organic products.

Biofertilizers is one of the important components of integrated nutrient management, as they are cost effective and renewable source of plant nutrients to supplement and/or replace the chemical fertilizers for sustainable agriculture. These are preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants' uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants.

Artificially multiplied cultures of efficient selected microorganisms play a vital role in accelerating the beneficial microbial processes in soil. Several microorganisms and their association with crop plants are being exploited in the production of biofertilizers. They can be grouped in different ways based on their nature and function as N<sub>2</sub> fixing, Phosphate Solubilizing, Phosphate Mobilizing, Biofertilizers for Micro nutrients and Plant Growth Promoting Rhizobacteria. The benefits of biofertilizers are longer shelf life, cause no harm to ecosystem and do not lose properties due to storage up to 45°C, hence greater potentials to compete with native population, cost effective, easier to processing viz., pulverization, neutralization, sterilization, packing and transport. Further it has the benefits of better survival on seeds and soil, very much easy to use by the farmer and very high enzymatic activity since contamination is nil.

The demand for biofertilizers is on the increase since the last

**\*Corresponding author:** Nagappan Raja, Department of Biology, Faculty of Natural and Computational Sciences, University of Gondar, Ethiopia, E-mail: [nagappanraja@yahoo.com](mailto:nagappanraja@yahoo.com)

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decade owing to its eco-friendly characteristics and a worldwide trend to reduce the reliance on chemically derived fertilizers. The global market for biofertilizers is expected to exceed a market worth of USD 10.2 billion by 2018. Asia-Pacific shared approximately 34% of the total demand in 2011. European and Latin American countries are the leading consumers of biofertilizers, owing to stringent regulations imposed to chemical fertilizers which would eventually be replaced by biofertilizers.

Biopesticides and biofertilizers are two important cornerstone needs intensive research to improve the quality primarily to achieve food security for the growing population and restore soil fertility.

Nature has provided countless avenues for research in these fields which needs to be explored. The development of new biopesticides with multiple mode of action against pests and biofertilizers with multi-crop growth promoting activities are most important for sustainable global agriculture. These two needs to be prioritized in agricultural research by universities, research organizations, R & D wings of manufacturers for technology development to the farming community. The technologies so developed need to be transferred worldwide to achieve maximum benefits to the society. The services of this journal disseminating knowledge on recent trends in biopesticides and biofertilizers in the previous issues were well appreciated by the scientific community.