Journal of Biofertilizers & Biopesticides

Kumar, J Biofertil Biopestici 2013, 4:2
DOI: 10.4172/2155-6202.1000e114

Editorial

Open Access

The Role of Biopesticides in Sustainably Feeding the Nine Billion Global Populations

Suresh Kumar*

Division of Biochemistry, Indian Agricultural Research Institute, New Delhi, India

The world population is expected to reach 9 billion by 2050. This global population growth of 2 to 3 billion people over the next 40 years, combined with the changing diets, would result in a predicted increase in food demand of 70% by 2050 [1,2]. To feed the burgeoning population, we need to produce more food and livelihood opportunities from less per capita arable land and water. Providing ample food for the ever-growing global population is only the first part of the challenge; the second and more important part is to produce this in a safe and sustainable manner [3]. There are certain other challenges in sustainably feeding the 9 billion global populations by the year 2050. Sustainability comprises of people, prosperity and the planet. For prosperity of the people, sustainable farming in an eco-friendly manner is must. While agriculture consumes about two-third of the fresh water, 11% of the world's land and 10% of the global petroleum, there would be several challenges in bringing sustainability to agriculture. The major challenges of sustainable farming are productivity, food quality and diminishing return of agricultural inputs.

The conventional approaches may not prove adequate to meet the projected food requirements, both in terms of quantity and quality of the food. Moreover, most of the cultivated crops/varieties have reached the yield plateau. Hence, crop protection to harvest maximum produce of the crops is one of the ways to meet the food demand of the growing population and to attain global food security on sustainable basis. Farmers, who were basically organic farmers, have adapted to green revolution technology characterized by the use of high yielding varieties (HYVs), chemical fertilizers and pesticides. Although intensive agriculture has so far been able to provide sufficient food grains for the growing global population, it treads heavily in the environment. Continuous use of HYVs without proper crop rotation has resulted in enhanced pest incidences. Insect-pest management in HYVs by extensive use of all sort of chemical pesticides has certainly provided protection to crops over the past decades; it has also raised concerns about pesticide residues in food and environmental pollutions. Therefore, the need of the day is to produce more and more food from decreasing availability of natural resources.

An integrated crop management approach needs to be deployed to counteract degradation of the agro-ecosystem due to the on-going intensive agriculture. This would include the use of biofertilizers and biopesticides, integrated pest management, soil and water conservation practices, biodiversity conservation etc. The increasing public concerns and growing awareness about the potential adverse environmental effects as well as health hazards associated with the use of synthetic plant protection and other agrochemicals has prompted search for the technologies and products which are safer for the end users and the environment. Due to the concerns of resistance development in pests and withdrawal of some of the products for either regulatory or commercial reasons, a lesser number of chemical pesticides are now available in the market. Natural pesticides are environment friendly and safer than classical chemical pesticides. Hence in the recent years considerable attention has been paid towards exploitation of biopesticides in protection of food crops/commodities from pest infestations and the associated losses.

Biopesticides, being natural products derived from materials such as plants, bacteria, viruses, minerals etc., are considered to be safer for the environment. They are usually less toxic than synthetic chemical pesticides, affect only the target pest and closely related organisms, often effective in small quantities and decompose naturally and quickly. More importantly, they can help minimizing the use of chemical pesticides and the associated environmental pollutions. When used in combination with conventional crop protection measures, biopesticides have been shown to improve pest control efficacy, enhance crop yield and become cost effective. When used as one of the components of an integrated pest management (IPM) program, biopesticides are targeted to particular pests and have high impact on pests and lowest impact on the environment. Typically, they do not persist longer in the environment after application, come from renewable sources and are safe for other organisms, farm workers and consumers of the produces. Al-shannaf et al. [4] evaluated efficiency of bioinsecticides and insect growth regulating chemicals against larvae of American bollworm (*Helicoverpa armigera*) and their side effects on common predators in Egyptian cotton field. Their results indicated that chemical insect growth regulators, though more effective against *H. armigera*, adversely affect non-target insects in the field.

As of early 2013 there were approximately 400 registered biopesticide active ingredients, and more than 1250 registered biopesticide products [5]. Increasing demands for residue-free crop produce, growing organic food market and easier registration than chemical pesticides are some of the key drivers of the biopesticide market [3]. The available biopesticides may be divided into three major categories: microbial, biochemical (or botanical) and plant-incorporated protectants. Microbial pesticides consist of microorganism (bacteria, fungi, viruses, or protozoans) or their derivative as active-ingredient, and they have been successfully being used in controlling insect pests. One of the most widely used microbial biopesticides is *Bacillus thuringiensis*, popularly known as Bt. The bacterium produces crystalline proteins and specifically kills one or a few related insect species. Biochemical or botanical pesticides are naturally occurring substances that control pest population by non-toxic mechanisms. Such examples are Azadirachtin from Neem tree, insect sex-pheromones (that interfere with their mating and population build-up), various scented extracts (that attract insect pests to traps) and some vegetable oils [6,7]. Sometimes it becomes difficult to determine whether a substance meets the criteria for classification as a biochemical pesticide, hence US Environmental

***Corresponding author:** Suresh Kumar, Division of Biochemistry, Indian Agricultural Research Institute, New Delhi, India, E-mail: sureshkumar3_in@yahoo.co.uk

Received August 12, 2013; **Accepted** August 13, 2013; **Published** August 16, 2013

Citation: Kumar S (2013) The Role of Biopesticides in Sustainably Feeding the Nine Billion Global Populations. J Biofertil Biopestici 4: e114. doi:10.4172/2155-6202.1000e114

Protection Agency has established a special committee to make such decisions. Plant-incorporated protectants include substances that are produced naturally on genetic modification of plants. Such examples are incorporation of *Bt* gene, protease inhibitor, lectines, chitinase etc. into the plant genome so that the transgenic plant synthesizes such biopesticide on its own. If transgenic technology is integrated into the traditional system of crop husbandry, probably it holds great promise in augmenting agricultural production, while conserving biodiversity, natural resources and the environment for future generations [8].

Pests are one of the major problems in crop husbandry. A major portion of expenditure on pesticides is for protecting the crop in the field. There has been an estimated 67,000 pest species that damage agricultural crops [9], and pest management is one of the important activities required to maximise crop production. In certain crops, e.g. Cotton, Brinjal etc. pest management constitute a significant part of the cost of the crop production. This not only requires purchase of chemicals, but considerable input is required on implements and labour required for their repeated applications on the standing crop. The current pest management strategies adopted for the intensive agriculture rely heavily on synthetic chemical pesticides which cause adverse/harmful effects on beneficial organisms, leave toxic residues in food and feed, and are considered to be harmful to the environment.

Storage pests and post-harvest losses significantly affect the availability of quality food. It has been estimated that approximately one-third of the world's food production (valued more than US$ 100 billion annually) is destroyed under storage, which is highest (43% of potential production) in the developing Asian and African countries [10]. Loss of food grains during storage is a serious threat to food security, particularly in developing countries where poor sanitation and inappropriate storage facilities encourage storage pests [11]. *Tribolium castaneum* is one of the important storage pests of cereals. Control of this insect relies mainly on the use of synthetic insecticides and fumigants which cause environmental pollution, pest resurgence, residual effects on the health of the grain consumers and harmful effects on non-target organisms [12].

Plant tissues from several species contain chemical compounds that are considered as defensive substances against their enemies. These include oils, alkaloids, organic acids and other compounds. Insecticidal and acaricidal properties of a number of plants have been well known, and some of these can compete with synthetic chemicals besides being environmentally safer [13]. Antifeedant, deterrent and repellents have been tested for pest control in the recent years [14-16]. Abbasi et al. [17] tested efficacy of *Calotropis Procera* and *Datura alba* extracts against the *Tribolium castaneum* in stored wheat grains and reported maximum repellency, mortality at higher concentrations of *C. sprocera* and *D. alba* on 3 months storage of wheat with minimum infestation/spoilage loss of the grain. Use of vegetable oils for protection of food grains in an environmentally safe manner has been recently reviewed by Singh et al. [7].

Recent Advances and Future Prospects

In addition to the continuous search for new biomolecules and improving efficiency of the known biopesticides, recombinant DNA technology is being deployed for enhancing efficacy of biopesticides. Fusion protein is being designed to develop next-generation biopesticides. The technology allows selected toxins (not toxic to higher animals) to be combined with a carrier protein which makes them toxic to insect pests when consumed orally, while they were effective only when injected into a prey organism by a predator [18]. The fusion protein may be produced as a recombinant protein in microbial system, which can be scaled up for industrial production and commercial formulations. Several other innovative approaches are being applied to develop biopesticides as effective, efficient and acceptable pest control measure among the farmers and common man.

To be readily acceptable by the end users, biopesticides must be effective in controlling the pest(s) that they are targeting to control. Many biopesticides target a single pest species, but it is always desirable to have biopesticide that can control a range of pest species. It is also believed that biological pesticides may be less vulnerable to genetic variations in plant populations that cause problems related to pesticide resistance. Biological pesticides are expected to provide predictable performance, and they must do so in an economically viable manner for their better acceptability and adaptability. Deployed appropriately, biopesticides have potential to bring sustainability to global agriculture for food security to the 9 billion people by the year 2050.

The Journal of Biofertilizers and Biopesticides, an open access international peer-reviewed journal, plays an important role towards dissemination of the new information generated by the researchers all over the world for the development and utilization of more effective biofertilizers and biopesticides, and creating awareness about these among the researchers, farmers, environmentalists, policy makers and the general public.

The views expressed here are those of the author only. It may not necessarily be the views of the institution/organization, the author is associated with.

References

1. Bruinsma J (2009) The resource outlook to 2050: By how much do land, water and crop yields need to increase by 2050? FAO Expert Meeting on 'How to Feed the World in 2050', Rome.
2. UNDESA (United Nations Department of Economic and Social Affairs) (2009) World population prospects: The 2008 revision, highlights, working Paper No. ESA/P/WP.210. New York, UN.
3. Kumar S (2012) Biopesticides: A need for food and environmental safety. J Biofertil Biopestici 3:e107.
4. Al-shannaf HM, Mead HM, Hassan Sabry AK (2012) Toxic and biochemical effects of some bioinsecticides and IGRs on American Bollworm, *Helicoverpa armigera* (hüb.) (noctuidae: lepidoptera) in Cotton Fields. J Biofertil Biopestici 3:118.
5. USEPA (United States Environmental Protection Agency) (2013) Regulating biopesticides.
6. Mazid S, Kalida JC, Rajkhowa RC (2011) A review on the use of biopesticides in insect pest management. Int J Sci Advanced Technol 1: 169-178.
7. Singh A, Khare A, Singh AP (2012) Use of vegetable oils as biopesticide in grain protection -A review. J Biofertil Biopestici 3:114.
8. Kumar S, Chandra A, Pandey KC (2008) Bacillus thuringiensis (Bt) transgenic crop: an environment friendly insect-pest management strategy. J Environ Biol 29: 641-653.
9. Ross MA, Lembi CA (1985) Applied weed science. Burgess Publishing Co, Minneapolis.
10. Ahmed S, Grainge M (1986) Potential of the neem tree (Azadirachta indica) for pest control and rural development. Eco Botany 40: 201-209.
11. Talukhdar FA (2005) Insects and insecticide resistance problems in post-harvest agriculture. Proceedings of international conference, post-harvest technology and quality management in arid tropics, Sultan Qaboos University.
12. Okenkwo EV, Okoye WI (1996) The efficacy of four seed powders and essential oils as protectants of cow pea and maize grains against infestation by *Collosobruchus maculantus* and *Sitophillus zeamais* in Nigeria. Intl J Pest Manag 42: 143-146.

13. Hedin PA, Hollingworth RM (1997) New Applications for Phytochemical Pest-Control Agents, In: Medin PA, Hollingworth RM, Maseler EP (Ed). Phytochemicals for pest control, American Chemical Society, Washington, USA.

14. Govindachari TR, Suresh G, Gopalakrishnan G, Wesley SD (2000) IInsect antifeedant and growth regulating activities of neem seed oil – the role of major tetranortriterpenoids. J Appl Ent 124: 287-291.

15. Ahmad S, Fiaz S, Riaz MA, Hussain A (2005) Comparative efficacy of crude extracts of *Calotropi sprocera*, *Datura alba* and imidacloprid on termites in sugarcane at Faisalabad. Pak Entomol 27: 11-14.

16. Rahman MM, Islam W (2007) Effect of acetonic extracts of *Calatropi sprocera* R Br-in (Ait) on reproductive potential of Flat grain beetle *Cryptolestespusillus*. Bangladesh J Sci Ind Res 42: 157-162.

17. Abbasi AB, Khan AA, Bibi R, Iqbal MS, Sherani J, *et al* (2012) Assessment of *Calotropis Procera* Aiton and *Datura alba* Nees leaves extracts as bio-Insecticides against *Tribolium castaneum* Herbst in stored wheat *Triticum Aestivum* L. J Biofertil Biopestici 3:126.

18. Fitches E, Edwards MG, Mee C, Grishin E, Gatehouse AM, et al. (2004) Fusion proteins containing insect-specific toxins as pest control agents: snowdrop lectin delivers fused insecticidal spider venom toxin to insect haemolymph following oral ingestion. J Insect Physiol 50: 61–71.