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APPLICATIONS OF GREEN CHEMISTRY PRINCIPLES IN AGRICULTURE

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Abstract

Green chemistry involves the design and development of products and processes that minimize or eliminate the use and generation of chemicals hazardous to the environment and human health. The principles of green chemistry involve the development of green catalysts and use of non-toxic reagents. Green chemistry emphasizes the use of reactions improved atom efficiency, use of solvent free or environmentally benign recyclable solvent system and use of renewable resources.

Nowadays, green chemistry play a new paradigm in the field of agriculture. Sustainable agriculture and green chemistry are both revolutionary fields and intertwined. In last few years, for sustainable production in agriculture use of renewable biomass resources increases to generate bio-based food products with low inputs, zero waste, substantial social values and minimizing environmental impact. This article provides a good insight about green chemistry principles in sustainable agriculture.

Keywords: *Green Chemistry, agriculture, pesticides, sustainable agriculture, chemical hazards*

INTRODUCTION: The problem of poverty in developing countries increases the demand of more productive and industrialized economies, which cause the global and local environmental pollution, and the non-sustainable use of natural resources. Environmental pollution threats, ranging from atmospheric pollution in cities, acid rain, municipal solid waste, deforestation and desertification, the reduction of ozone layer and signs of climate change were overlooked. The idea of sustainable eco-development was presented for the first time in 1987 in the report of the World Commission on Environment and Development of the United Nations.

In last few years, the production of synthetic pescticides was increasing and the modern agriculture methods produced major green house gases e.g. emission of 84 % nitrous oxide (N_2O) annually in all over the world.

The adverse impact of contamination in agrochemical fields through indirect or direct exposure of improper use of pesticides, effects the animals and human health. Pesticides includes all chemicals which are used to control or kill the pests, but these pesticides in food chain coupled with biomagnifications and bioaccumulation having adverse effects on entire animals and human life. To minimize these harmful effects, employment of organic farming should be increased in place of synthetic pesticides.

These pesticides also causes the contamination of ground water and led to eutrophication of rivers and lake waters, and the movement of toxic chemicals from surroundings into an organism. There are some pesticides e.g. DDT, which are soluble and accumulate in fatty tissues and causes biomagnifications in food chain.

Green chemistry involves the design and development of products and processes that minimize or eliminate the use and generation of chemicals hazardous to the environment and human health. The principles of green chemistry involve the development of green catalysts and use of non-toxic reagents. Green chemistry emphasizes the use of reactions improved atom efficiency, use of solvent free or environmentally benign recyclable solvent system and use of renewable resources.

GREEN CHEMISTRY: In 1998, **Paul Anastas** and **John C. Warner** developed the 12 principles of green chemistry. Green chemistry starts with molecular level and eventually indicating the most important environmentally benign processes and products. In 2001, at University of Colorado, Boulder, IUPAC CHEMRAWN XIV Conference on Green Chemistry: Towards Environmentally Benign Processes and Products, was organized and in this conference a number of chemists discuss the effects of agricultural and industrial activities on atmospheric chemistry. They advised "design-for-environment" framework to work with consumers and assure the safety of foods and crops developed by green methods for green agricultural practice.

Nowadays, green chemistry play a new paradigm in the field of agriculture. In last few years, for sustainable production in agriculture use of renewable biomass resources increases to generate bio-based food products with low inputs, zero waste, substantial social values and minimizing environmental impact. Sustainability of agriculture is the core area which requires green chemistry strategies in agrochemical field for implanting the judicious use of pesticide and fertilizers.

GREEN PRINCIPLES APPLICATION IN AGRICULTURE

- Beginning with the selection of renewable, non-toxic feedstocks,
- The design of safe and energy efficient synthetic procedures
- Maximum incorporation of all materials into the product, eliminating auxiliaries when possible,
- Generating durable, non-toxic products with preserved function,

- Ensuring the natural degradability of all products and by-products at the end of life.
- The principles of green chemistry are especially relevant to the manufacturing of agrichemicals due to their direct impact on human and environment health. However, current agricultural practices are still based on intensive production methods using unsustainable technologies developed during the 'green revolution'.
- This technology is characterized by the extensive use of high yielding crop varieties, chemical fertilizers, pesticides and irrigation. According to market research by FoodThink, 66% of Americans feel the agriculture industry is not transparent about food production practices citing primary concerns of the use of pesticides and insecticides, animal antibiotics, and animal hormones.
- As consumer focus shifts towards establishing a sustainable and secure food supply, the agrichemical industry will require a second 'green revolution' utilizing green chemistry principles to continue providing products relevant to agricultural practices.
- The bio pesticides itself has scalable and green technology which has direct implication on sustainable agriculture for broad range production. The innovative work used for the preparation of biocatalysis processes using reductases, transaminaes, oxidases, hydrolases etc. Nowadays, innovative enzymes are used for synthesis of biocatalysts which offered economical benefits in pharmaceutical and agriculture.
- Nowaday, the manufacturer emphasizing the replacement of conventional solvents to green solvents for worker safety in chemical and environmental protection. The selection of right solvents has always increase the benefits to environment, safer to user and improved awareness. Currently, the green solvents represented the around 10% market. In the last few years, laboratory synthesis and manufacturing in industry replacing into catalyst free reactions and catalyst free reactions on water and in water.
- Recently, organic solvents with high volatility and inherent toxicity were change by the ionic liquids (ILs). Ionic liquids are organic salts usually melt below 100^0C , high thermal stability, nearly non-volatility under normal conditions, dissolve non-polar and polar organic, inorganic compounds. For these reason, ionic liquids called "designer solvents".
- The renewable energy resources such as solar, wind, hydroelectric, biomass, biorefifineries, geothermal and ocean energy are important resources for future sustainable development, so it will replace carbon containing sources and reduces the emission of global warming. In the last years, third-generation biofuels (high yielding-low input feedstock) derived from renewable feedstock.
- There are 234 registered pesticides in india. Out of them, 4 are WHO class Ia pesticides, 15 are WHO class Ib pesticides and 76 are who class II pesticides. Initially in 1952, a plant for production of BHC started in India and now in Asia, India is the second largest manufacturers in pesticides. In India, 76% of pesticides used is insecticides, as against 44% globally.
- Recently, a large number of deaths of farmers increases due to pesticides poisoning. There is a list of highly or extremely hazardous seven pesticides which are continued to be used in India despite of being banned in many countries. Pesticides like Monocrotophos and Oxydemeton-methyl are considered Class-I pesticides by WHO. "Since Class-I pesticides can be fatal at a very low dose, many of these are banned in several countries", but allowed to sold in India and still use of these pesticides in some area of countries, which cause death of farmers. In India, according to official estimate, death of at least 10,000 people every year due to direct pesticide poisoning.
- As we see some of the chemicals still used conventionally in agriculture which are associated with adverse impacts to environment and human health. There are growing concern towards about how we farm for sustainable agriculture, what inputs would supply to it, what technologies to employ. The green chemistry will shift the agriculture towards sustainable development.

FURTHER DISCUSSION: Green chemistry seeking the goal towards farm profitability, community prosperity and improving soil quality by reducing the dependence use of non-renewable resources e.g synthetic fertilizers and pesticides, minimizing the adverse effects on water quality, wildlife and safety. There are various alternatives of chemical farming such as biological agriculture, organic farming, natural farming, bio-dynamic agriculture, ecological agriculture. Bio-pesticides are organic in nature, so these can be employed in farming for controlling the pests, insects, weeds and also for plant physiology and productivity. These bio pesticides are bio-degradable to the environment. Therefore, for sustainable developments, shift the agricultural farming into green chemistry manufacturing processes, use of crop protection and production and develop green agrochemicals.

Thus, sustainable agriculture and green chemistry are both revolutionary fields and intertwined. For this green chemists needs that the farmers used green technology for sustainable agriculture and farmers needs safe and green agricultural inputs. The biocatalysts have been used increasingly in agrochemicals, pharmaceuticals and food industries, these can help in reducing the waste and improving the yield of products.

The population of world stands at 7 billion and increases upto 9.3 billion by 2050. This will required food production to be increased by 70% in order to meet the demand. Therefore, it is necessary to increases the crop productivity, reduced pre-harvest loss and post harvest lost from pest attack by employing biochemical processes with green techniques.

The agrochemical industries have carrying major growth in futures. The industry, regulatory bodies, government and academia can build a collaborative work together and employs their ideas of green chemistry practices.

CONCLUSION: There are mainly three aspects by which green chemistry connects with sustainable agriculture. First, the principle of green chemistry recommended the use of bio-based materials or use feedstock or raw materials which are renewable e.g. agricultural waste products. Chemists should emphasize the work on developing the bio pesticides, bio-fertilizers and biocatalysts for transforming the agricultural materials into high value products and also enhancing their production and protection.

Secondly, use of green chemistry in site remediation by interaction with agriculture. In a traditional farming, farmers do not know how to deal with valuable tool, leave some unwanted chemicals which contaminated the environment (in soil, air and water). Green chemists at Carnegie Mellon University have investigated the TAML® catalysts. This green catalyst is safe to remove the specific chemicals including pesticides, from water. Thus, green chemists to help the farmers how to tackle with contamination, removing pollutant, unwanted chemicals and manage the use of recycled water.

At last, green chemistry generates the new green inputs for sustainable agriculture productions and protections.

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