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ORIGINAL PAPER

Controlled biofertilizer release kinetics and moisture retention in gum xanthan-based IPN

Sukriti[1] · **B. S. Kaith**[1] · **Rajeev Jindal**[1]

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Abstract A crosslinked interpenetrating network based on gum xanthan was produced in the presence of gamma radiation and its potential as controlled release fertilizer was evaluated. Different process parameters such as gamma radiation dose, solvent amount, crosslinker and monomer concentrations were optimized to determine the maximum fluid uptake capacity of the synthesized sample. The samples were characterized using FTIR, XRD and SEM. The thermal stability was investigated using TGA, DTG and DTA techniques. The biofertilizer extracted from vermicompost was used as model agro-chemical and the presence of essential macro- and micronutrients in the biofertilizer was confirmed by chemical analysis. The in vitro release kinetics was administered by Korsmeyer–Peppas model. Release exponents were found in the range of 0.8–0.9, signifying the non-Fickian mode of diffusion where the relaxation of polymer matrix also played an important role. Further, the impact of biofertilizer control release on *Cicer arietinum* plant growth was investigated and it was found that there was an increase in stem and root bio-mass. The synthesized candidate polymer was found to act as a mini-water reservoir in different soil types and prolonged soil moisture for more than 50 days. Therefore, the synthesized superabsorbent with controlled release of biofertilizer can protect the environment from adverse effects of carcinogenic synthetic fertilizer leaching, along with its functionality to act as water reservoir in the fields.

Keywords Gum xanthan · Gamma radiation · Biofertilizer · Vermicompost · Mini-water reservoir

Introduction

During 1960s, Norman Borlaug introduced a new technology in the sector of agriculture which could save billions of people from starvation and gave the birth to "Green Revolution" [1]. This revolutionized the agriculture sector through the development of high-yielding varieties of cereal grains, modernization of management techniques and promoting use of fertilizers and pesticides. This revolution had a great impact on the expansion of Indian economy and India could achieve food self-sufficiency [2]. Although, this revolution proved to be highly fruitful and could solve the food problem but in the long run it resulted in many serious concerns like killing of the beneficial soil organism, destruction of natural soil fertility, making the crops more susceptible to pests as well as other diseases and weakening of the natural "biological resistance". At present, usage of chemical fertilizers is increasing with the rapid rate of 2.5 million metric tonnes per annum [3]. It has been observed that only 1/4th of the total fertilizer dose is taken up by the plants, and this dose actually reaches the plants to produce biological response. More than 50% would end up as waste due to surface runoff, leaching and evaporation. The leachate from the fields enters fresh water sources and algae growth is promoted leading to eutrophication which results in enhanced BOD and COD levels [4]. Level of agrochemicals in water above the permissible limit leads to biomagnification and results in serious health hazards [5]. On the other hand, the rising cost of fertilizers also is of concern which is due to increase in fossil fuels cost along with the

✉ Sukriti
sukriti.chemistry@gmail.com

[1] Department of Chemistry, Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, Punjab, India