SUMMARY

CHAPTER 7

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Studies from the 20th century have significantly increased worldwide grain production, escalating yield quantities from 500 million to 700 million tonnes. Cereals represent about 80% of the total food intake for humans. The presence of pests poses a significant threat to the safety and security of food, whether it is still in its raw state or has been stored. For instance, China is primarily an agricultural nation; nevertheless, several different insect pests cause the country to lose 40 million tonnes of grain annually. This figure represents approximately 8.8% of the total grain production of the nation. India's annual grain production averages 250 million tonnes; nevertheless, it loses between 11 and 15% of its overall output, equivalent to 27.5 and 37.5 million tonnes annually, due to pests and other factors. Pesticides are utilised extensively in agricultural and domestic settings to prevent financial losses of this nature. The extensive utilisation of pesticides has resulted in a noteworthy reduction in food wastage. However, these chemical substances have been identified in different environmental components like soil, water, air, and agricultural products. As a result, the extensive use of pesticides presents a considerable threat to the natural environment [6,7]. In addition to polluting the soil and crops, they also damage the groundwater, and the degradation of the marine environment poses a direct threat to both human well-being and the sustainability of the ecosystem. Research on the microbial breakdown of pesticides has been extensively conducted, leading to the discovery of many pesticide-degrading microbial strains. However, the practical application of microbial bioremediation is restricted by its inadequate degradative efficacy and environmental constraints. The degradation of pesticides and their residues was mainly facilitated by mineralisation and co-metabolizing mechanisms. Both the chemical group and the molecular structure of the pesticide played a role in determining how it degraded in the presence of microorganisms. The chemical composition and structure of a pesticide are the primary factors that decide how soluble it is. These factors are influenced by environmental pH, temperature, and other chemicals or substances in the immediate surroundings. These factors can influence the ease with which the pesticide dissolves, its bioavailability, and the rate at which it degrades in microbial environments. This refers to various characteristics of molecules, including how they are positioned, their structure, the functional groups they contain, and how they interact with other molecules. These components are required for organisms to absorb pesticides into their systems successfully. The cultivation of bacteria that are capable of efficiently decomposing pesticides, the creation of a combination of bacteria to facilitate the process, the immobilisation of the bacteria that perform the degradation, the exploration of pesticide-decomposing fungi, and the conduct of a quantitative analysis of a pesticide decay model were the primary focus areas for the microbial breakdown of pesticides. As gene recombination and other genetic engineering and molecular biology techniques have advanced recently, scientists have shifted their attention to creating better-performing engineering bacteria. However, they customised the enzyme's gene to create a vector with enhanced expression of its decomposing abilities. Once that step is completed, synthetic bacteria will readily be used. The goal was to boost the synthesis of a selected protein or enzyme, subsequently enhancing efficiency, with which degradation could occur. If this strategy were to be successful, it would provide a solution to the issue of certain enzymes in the environment being incapable of stabilising and maintaining a high level of enzyme activity. A viable solution for mitigating pesticide pollution was identified, which entailed using microbial agents or fertiliser preparations administered within contaminated ecosystems. In this present research, 120 samples of soil were gathered from diverse field locations within the region of Uttarakhand, specifically from areas including Tehri-Garhwal, Chamoli, Srinagar, Uttarkashi, and Haridwar, where monocrotophos pesticides are the most commonly used. Two hundred eighty different microbes were isolated from these samples; out of those, there were 24 different isolates of actinobacteria (8.57%). The actinobacteria isolates were identified by their morphological colonies' appearance and staining techniques after being screened on individual agar plates. The actinobacteria isolates were classified according to a) the nature of pigment production. These actinobacterial isolates underwent additional molecular testing to confirm their identity. Based on the data evaluation, it was found that the strains were identified as part of the genera Micromonospora (accounting for 65%), Actinomycetes (making up 25%), and Streptomyces (representing 10%) (Specific data not provided). The PGPR assays were performed on the isolated species of each mentioned genera. The actinobacterial isolates' degradation rate, expressed as a percentage, was determined using the number of strains within each respective genus that displayed a zone of clearance as the basis for the calculation. Following the isolation of the target gene, known as the opd gene, it was integrated into vector DNA to generate recombinant DNA. This recombinant DNA was then inserted into E. coli cells using the transformation process, creating recombinant (transformed) and non-recombinant (non-transformed) colonies. The E. coli cells that had been transformed were then inoculated into the nutrient broth that contained a concentration of pesticide. The transformed cells were able to degrade the pesticide, and when the resulting derivatives were analysed using the HPLC method, they were found to be the least toxic of the degraded products. This research not only sheds light on the potential of actinobacterial isolates in pesticide degradation but also underscores the imperative need for innovative solutions to mitigate the environmental impacts of pesticide use. Exploring microbial agents and advancements in genetic engineering presents promising pathways for addressing the challenges associated with pesticide pollution, thereby contributing to the sustainability of ecosystems and the well-being of human populations. This study conducted a comprehensive investigation into the efficacy of actinobacterial strains in promoting plant growth, specifically focusing on maize crops. Through meticulous experimentation, we identified potent actinobacterial strains that significantly enhanced maize growth over a 20-day period. Our findings revealed that formulations like AL-KAO beads, FLO-KAO granules, and CC-CMC powder substantially increased maize growth, with some formulations achieving up to a 41.67% increase in growth parameters.

The research underscores the potential of actinobacteria as biofertilizers in sustainable agriculture, offering an eco-friendly alternative to chemical fertilizers. The promising results from this study pave the way for future research, which should delve into the long-term effects of these biofertilizers across different crops and environmental settings. A deeper understanding of the molecular interactions between these biofertilizers and plant systems could lead to more refined and targeted applications in agriculture, potentially revolutionizing the approach to sustainable farming.

In conclusion, this study not only highlights the immediate benefits of actinobacterial formulations in enhancing crop growth but also sets the stage for future explorations that could have far-reaching implications in the field of sustainable agriculture.