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IMPACT OF ANTIBIOTICS ON PLANT GROWTH

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ABSTRACT

The production and use of veterinary antibiotics has increased rapidly worldwide over the last few decades. However, when these antibiotics are excreted or when used as a part of organic manure, they are spread over the crop land hence plant growth and development might be affected. Impacts on human health through the consumption of antibiotic exposed crop plants have been intensively investigated. Information is still lacking on the effects of antibiotics on plants themselves, particularly on crop species, although evidence suggests adverse effects of antibiotics on growth and performance of plants. This study evaluates the effects of the two antibiotics namely chlortetracycline and tetracycline. Tetracycline, chlortetracycline and tylosin had very little effects on soil respiration while sulfamethoxazole, sulfamethazine and trimethoprim showed temporal effects on properties like soil respiration. Sulfonamides (sulfamethoxazole and sulfamethazine) and trimethoprim are the two groups of antibiotics which were found to be most toxic to plant when it was grown in soil. The main aim and objective of this study is to evaluate experimental evidence of plant-pharmaceuticals interaction, their uptake and their removal by plants and to suggest an open area of research in this new field.

KEYWORDS: Antibiotics, Sorption, Degradation and Soil Respiration.

INTRODUCTION

Bacterial infections can be prevented by using antibiotics (also known as antibacterial) which is a type of antimicrobial drug. There are two types of antibiotics bactericidal and bacteriostatic. Bactericidal antibiotic that kills bacteria where as bacteriostatic antibiotic that inhibit the growth and reproduction of bacteria.[1] Antibiotics have been in use for less than a

century. In 1928 the first antibiotic penicillin was isolated from the fungus penicillium by Alexander Fleming.[1] After the discovery of penicillin, streptomycin was discovered by Selman Waksman. Streptomycin was isolated from the bacterial genus streptomyces which is found naturally in soil, and is an antibiotic cure for many intestinal diseases.[1]

Antibiotics are generally classified based on the basis of three broad mechanism of action. 1. Disrupt bacterial cell envelope. 2. Block production of new proteins and 3. Inhibit DNA replication. Beta-lactams group of antibiotics inhibit cell wall synthesis where as Macrolides and Aminoglycosides group of antibiotics inhibit protein synthesis.[2]

Use of antibiotics: There are different routes of administration for antibiotic treatment. They are usually taken orally. In severe cases of infections antibiotics may be given intravenously or by injection. Despite tremendous advancements within the drug delivery analysis[2], oral route remains the well-liked route administration of medicine owing to low value of medical care, easy administration, patient compliance etc. Stimuli sensitive polymers are generally used in the delivery system for the targeting of specific segments of gastrointestinal.[2] A small change in environmental condition like pH and temperature etc shows a sharp change in their properties. This behaviour of the polymers can be utilised for the preparations of smart drug delivery system. Oral pH sensitive drug delivery system is one of the important systems that deliver the drug at specific part of GI as per the pH of gastrointestinal which results in the improvement of patient therapeutic efficacy and compliance. Oral gastro retentive pH sensitive systems like floating and bio adhesive drug delivery systems would be improve the targeting of gastric and duodenum infection of Helicobacter pylori.[3]

What is antibiotc resistance marker gene and why is it used?

The process of inserting a gene of interest into a plant is crucial. Scientists will not merely verify wherever a gene can land, or may be if gene has been with success incorporated into a plant cell. Gene can be inserted by two common ways. The first method is gene gun, where microscopic particles covered with DNA and with high velocity inserted in to the target organism. The second method uses a sort of bacterium, with the gene of interest attached to infect a plant and thus insert the gene.[4] Genetic engineers use these ways to insert the gene, however want an additional tool to determine if the gene of interest ends up within the host organism. As a result of this imprecision, scientists use Gene marker for identification of which plant cell having gene of interest. Gene marker is nothing but it is a part of gene cassette which includes both gene of interest and powerful promoter that functions “genetic

on" switch.[4] for example, if genetic engineer wants to incorporate a gene from fish to tomato plant, for this she will isolate a gene from fish which is attached with both promoter and gene marker. In the end inserted in to the tomato plant through gene gun method.[4] The primary gene markers are either antibiotic resistance or herbicide tolerance. if herbicide tolerance gene is used as the selectable marker, or it can be added to plant media which may kill the plant cells thus insertion of antibiotic resistance marker gene could not be possible. As a result gene will remain live.[5]

Plant hormone – amino acid conjugation

In plants, amino acid conjugates to IAA and JA dramatically alter the biological role of these molecules. Amino acid conjugation of auxin plays central role in their homeostasis.[5] For IAA, the free acid is the biologically active form of the hormone, with amino acid conjugation leading to inactivation. The metabolic fate of conjugated IAA depends on which amino acids are attached. Conjugation of IAA with either aspartate or glutamate leads to hormone degradation. IAA-Trp act as anti-auxin to inhibit plant growth effects but does not compete with IAA for binding to the TIR1 auxin receptor.[5]

In plant the enzyme that catalyze amino acid conjugation of plant hormone belong to the GH3 (Gretchen Hagen 3) family of acyl acid- amindo synthase. The first GH3 gene was identified in 1985 as an early auxin- responsive gene in glycine max (soyabean).[6] As with the SABATH and MES families multiple genes encode GH3 proteins in each plant. For example, A-thaliana and rice encode 19 and 13 GH3 proteins respectively. Genetic and physiological studies of various GH3 proteins indicate a diverse range of biological functions for these enzymes in jasmonate and auxin hormone signalling and for SA-related pathogen responses.[7]

Plant hormone- hydrolases: As with amino acid- conjugated hormone can be hydrolyzed back to the free hormone and aminoacid. The first hydrolase discovered with this activity was identified from a mutant screen of arabidopsis which is looking resistance to IAA-Leu (IL) treatment. The ILR (IAA-Leu resistant) proteins belong to the M20 peptidase superfamily of which there are six homologs in arabiopsis. Most enzyme in the M20 peptidase family are Zn+2 dependent but ILR proteins prefer Mn+2. In the crysatlline structure of ILR, the larger domain consists of active site and 8 β- strands with α helical bundle on both sides. While in the smaller satellite domain adopts a α/β- sandwich topology.[8]

Phytotoxicity: Several studies were carried out in aqueous solution or nutrient medium doped with different pharmaceuticals for assessing phytotoxicity effects on different crop plants. The root growth and development of Pinto beans (Phaseolus vulgaris) were markedly decreased by both chlortetracycline and oxytetracycline antibiotics as their concentrations were increased. Plant mortality increased as the antibiotic concentrations increased, and all plants died at the 160-mg/L level. The antibiotics might be directly phytotoxic, but also the degradation products might be directly or indirectly phytotoxic or the complexes formed with Ca2+ might induce Ca deficiency in the plants. Oxytetracycline also had a significant inhibitory effect on alfalfa (Medicago sativa) growth at concentrations higher than 0.02mM (9.2mg/ml) Oxytetracycline phytotoxicity might be caused by inhibition of the translational activity of chloroplast and chloroplast (p)ppGpp synthase activity. Root growth was more sensitive to oxytetracycline than shoot.[9]

CONCLUSION

Plants can actively uptake pharmaceuticals from solution and soils, compound bioavailability being dependent on the environmental matrix. Interesting results have been found related to biochemical processes occurring with pharmaceuticals in plants, which indicate that plants possess mechanisms to cope with pharmaceutical compound toxicity and can eliminate them. From an agricultural point of view, pharmaceutical uptake by plants poses a threat for human health; nevertheless, the risk associated is considered to be low. Nevertheless, there are a number of knowledge gaps that still need to be addressed.[10]

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