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ORIGINAL PAPER

Bacillus: The genus with multitude roles in plant disease management

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ABSTRACT

Bacillus spp. secrete different types of compounds act in biocontrol of plant pathogens and to promote plant growth. It secretes extracellular metabolites like antibiotics, cell wall degrading enzymes and siderophores. It triggers induced systemic resistance (ISR) in plants as a response to pathogen attack. Further, it promotes plant growth by fixing nitrogen, solubilizing phosphate and producing phytohormones. Numerous *Bacillus* spp. were identified day to day by studying the potential in plant growth promotion and as biocontrol agents. Predicting efficient biocontrol agent is an ultimate task for the effective utilization of *Bacillus* spp. in agriculture.

Keywords: Bacillus, biocontrol agents, antibiotics, lytic enzymes, induced systemic resistance.

INTRODUCTION

Bacillus spp. are rod shaped bacteria which are gram positive and survives in aerobic or facultative anaerobic condition. It forms endospores during adverse environmental condition, which encompass the adaptability to varied environments. It is present in soil, rhizosphere, endophytic and in aerial parts of the plant. These are diverse group belong to *Firmicutes*, which are non-pathogenic as major and pathogenic bacteria. Their rapid multiplication rate, formation of endospores and secretive metabolites placed this group as a commercially utilizing in different application. Some of the beneficial strains are *Bacillus subtilis*, *B. cereus, B. amyloliquefaciens*, *B. pumilus*, *B. licheniformis*, *B. megaterium*, *B. velezensis*, *B. sonorensis, Paenibacillus polymyxa, B.*

brevis, B. vallismortis, B. circulans, B. coagulans and *B. thuringiensis*, etc. These genera are named for the production of antibiotics, lytic enzymes, siderophores, induction of systemic resistance in plants, nutrient availability in plants, phytohormone production, volatiles production.

ANTIBIOTICS

The secondary metabolites produced by the *Bacillus* spp. are the major thrust area of antibiotic properties. These are low molecular peptides produced by ribosomal origin which are bacteriocins or non-ribosomal origin which are lipopeptides, peptides, polyketides. Bacteriocins are peptides produced by numerous bacteria which are useful against pathogenic and antibiotic resistant bacteria. It acts on the cell walls and forms pores on the cell membrane. Bacteriocin like substances are produced by different *Bacillus* spp. such as amylosin, amysin, subtilin, subtilosin A, subtilosin B, thuricin. The antimicrobial activity is stronger when it produces non-ribosomal peptides. Cyclic lipopeptides (LPs) are produced by large-ribosomal peptide synthases (NRPs) which attack the cell membrane of the host pathogen. It alters the structure and permeability of the membrane through disruption, solubilization and ion conducting pore formation and also interact with DNA. These are required for the colonization in rhizosphere and to induce plant defense. These are surfactin, iturin, and fengycin families have amino acids, amino pr hydroxyl fatty acids with hydrocarbons of varying length. Surfactin, lichenysin, pumilacidin, halobacilin, bamilocyn are heptapeptide surfactins having both antibacterial and antifungal properties. Iturin, mycosubtili, bacillomycin, bacillopeptins, mixirins, mojavensin, subtulene are heptapeptide iturin with wide range of antifungal properties compared with antibacterial activity. Fengycin, plipatatin, maltacin are decapeptide fengycin which have antifungal properties.

Kurstakins, bacitracins, polymyxins, gramicidins and tyrocidines are other non-ribosomal lipopeptides. Non-ribosomal peptides such as bacilysin, rhizocticin, amicoumacin, mycobacillin, diketopiperazines and polyketides such as bacillaene, dihydrobacillaene, difficidin, macrolactin having wide range of antifungal and antibacterial activities.

LYTIC ENZYMES

Chitinases, glucanases, chitosanases, cellulases, lipases and proteases are the lytic enzymes produced by *Bacillus* spp. These enzymes hydrolyse the cell wall of the pathogen and there by causing the leakage of protoplasm. The cell wall of fungi contains chitin, glucan, cellulose, lipids and proteins. These cell wall components are cleaved by the hydrolytic enzymes. The degrading activities are done by the combination of more than one enzyme for the effective antifungal activity. Further, the right combinations of enzymatic activities on the fungal cell wall are required for the increased antifungal activity.

SIDEROPHORES

The metal chelating peptides which have low molecular weight are produced non-ribosomally under iron starvation condition. The main biological functions in the microorganisms require iron (Fe) which was chelated by the *Bacillus* spp. without allowing for pathogen by providing competition for Fe. There are three families in siderophores such as ydroxamates, catecholates, and carboxylates. Bacillibactin, pyoverdine, pyochelin, schizokinen, petrobactin, itoic acid. *Bacillus* spp. produces better siderophores than other bacteria isolates.

INDUCED SYSTEMIC RESISTANCE

The stimulation of defense mechanism in plants systemically due to the interaction with non-pathogenic microorganisms is induced systemic resistance (ISR) whereas localized infection induces systemic acquired resistance (SAR). Jasmonic acid (JA) or ethylene dependent signalling pathways are initiated during ISR, meanwhile salicylic acid (SA) mediated pathway was initiated in SAR. Further pathogenesis related (PR) proteins are produced due to the activation of defense related genes followed by SAR. The production of different metabolites or root exudates by the plants attracts different microorganisms which can interact with the plants. This situation initiates the systemic resistance in plants through various signalling pathways. Among all the *Bacillus* spp. are capable of producing antibiotics, siderophores and various metabolites and thereby initiates the defense response in plants. *Bacillus* spp. can elicit the antioxidant enzymes activities in plants such as peroxidase (POX), polyphenol oxidase (PPO), phenylalanine ammonia-lyase (PAL), and superoxide dismutase (SOD).

NUTRIENT MOBILIZING

Bacillus spp. are very good fixer of nitrogen and effective phosphate solubilizer which aids in uptake of nutrients by the plants. Several *Bacillus* spp. are reported to have *nif* genes which are helpful in fixing the atmospheric nitrogen in the soil. Biological nitrogen fixation is the process by which the microorganisms fix the atmospheric nitrogen in the soil to make it available for plants. Further *Bacillus* spp. solubilizes insoluble inorganic P and mineralization of insoluble organic P through the secretion of inorganic and organic acids, protons, siderophores, hydroxyl ions and extracellular enzymes.

PHYTOHORMONE

Plant growth regulators or phytohormones are the substances which are required for the physiological activities in plants at low concentrations. These are auxins, cytokinins, gibberellic acid, ethylene and abscisic acid. These hormones have different activities such as cell division, cell elongation, tissue differentiation, seed germination, flowering, fruiting, stem elongation, apical dominance, nutrient mobilization, leaf senescence, maturation and stress tolerance. Different *Bacillus* spp.

are known to produce these phytohormones which can regulate the plant growth and physiological activities.

VOLATILES

Volatile organic compounds (VOCs) are low molecular weight compounds with high vapor pressure which are produced during secondary metabolism. These VOCs aids in plant growth promotion, plant defense induction, cell-cell communication, inhibit the growth of other microorganisms and so on. Majority of the VOCs are belonged to ketones, nitrogen-containing compounds, hydrocarbons, aromatic compounds, alcohols, aldehydes, acids, esters, sulfur containing compounds, silicone containing compounds, ethers, halogenated compounds, naphthalenes and pyranones. 2,3-butanediol and acetoin are the compounds responsible for plant growth promotion was detected in *Bacillus subtilis* GB03 and *B. amyloliquefaciens* IN937a. Every compound has specific activity either in group or singly. VOCs in a play a major role in plant disease management which can be further exploited for its usage.

CONCLUSION

Bacillus spp. are present in larger proportions in rhizosphere compared to other microorganisms. The formation of endospore aids in survival of the genus in unfavourable environment. The production of antibiotics, siderophores, phytohormones, volatiles, lytic enzymes and nutrient mobilising play a vital role in utilizing this genus in plant growth promotion and disease management. These different roles possessed by the *Bacillus* spp. make it to use as a biocontrol agent.

REFERENCES

Kai M (2020) Diversity and distribution of volatile secondary metabolites throughout *Bacillus subtilis* isolates. *Front. Microbiol.* 11:559.

Miljaković, D., Marinković, J., and Balešević-Tubić, S. (2020). The significance of *Bacillus* spp. in disease suppression and growth promotion of field and vegetable crops. *Microorganisms*, *8*(7), 1037. https://doi.org/10.3390/microorganisms8071037.

Radhakrishnan R, Hashem A, Abd Allah EF. (2017). *Bacillus*: A biological tool for crop improvement through bio-molecular changes in adverse environments. *Front Physiol*. 8:667. doi:10.3389/fphys.2017.00667

Tahir, H. A., Gu, Q., Wu, H., Niu, Y., Huo, R., & Gao, X. (2017). *Bacillus* volatiles adversely affect the physiology and ultra-structure of *Ralstonia solanacearum* and induce systemic resistance in tobacco against bacterial wilt. *Scientific reports*, *7*, 40481. https://doi.org/10.1038/srep40481