Chapter 1

Introduction

Gujarat having highly fertile land thus it is the best place for crop production. Now a days in agriculture sector, the usage of chemical fertilizers and pesticides has greatly augmented. Moreover, its expressions have severe effects on human health issues, environment, and ground water level. Currently agricultural practice is followed to utilize chemicals like fertilizers and pesticides. During the Industrial Revolution at mid-19th century chemical fertilizers were applied to the agricultural field for fast crop productivity. Almost all of the farmer utilized chemical fertilizers to enhance fertility as well as crop yield but it may decrease the yield and may cause diseases to plants and humans. Overuse of chemical fertilizers causes acidification of soil and crust which may lead to decrement in organic matters, humus content of soil, many other beneficial organisms enhancing the fertility and crop yield, and also varies pH of soil. It also plays a prime role to increment of greenhouse gases that may increase global warming can cause serious health issues to human beings. As the soil is converted to acidic nature it diminishes mineral intake and increases the concentration of harmful ions in soil also reduces the nutrient holding capacity as it decreases the humid content of soil. Hence loose soil fertility and crop yield. The unacceptable effects of agrochemicals which can resist pests and pathogens that accrue in soil surface, water and air and cause negative impact to outbreak of the subordinate pests (Reddy *et al.,* 2014). Pest and plant pathogen foremost to adverse effects on plant and causes soil borne infections.It may lead to various plant diseases such as wilt, root rot disease, tikka disease, early and late blight, crown gall, foliar disease etc. It may also lead to curling of leaves and develops blackish spots on leaves, and damages the margin of plant leaf ant roots. Thus diminishes the plant yield, early fall of plant, drying of soil. Hence to overcome these problems now a day's organic farming practices fascinating the devotion of investigators and the public too with augmented the health consciousness, safety. Soil management practices is much important to protect and conserve the agricultural land. Organic farming came into practice during 20th century, which usages eco-friendly organic matter and reducing the effects of chemicals and decrease the expenses for farming practices (Abbas *et al.,* 2020). Organic farming leading to pollution free environment and sustainable agricultural practices. It maintains the soil health and crop productivity. Soil contains natural micro flora includes a huge variety of beneficial bacteria, cyanobacteria, fungi, and mycorrhiza commonly known as plant growth-promoting

rhizobacteria (PGPR). Beneficial soil microbes are significantly playing a numerous role, including increases micro and macro nutrients in soil, converting insoluble nutrient to soluble nutrient and able to transfer nutrients into plant, and defensive to both soil and plants from pathogens and pest. A key part of the advantages to use the microbes as bio fertilizers that can promote the nutrient value of soil as well make nutrient bound in the soluble inorganic compound by biodegradation of organic matters that can utilized by the plants. Other property of PGPR includes to release the bioactive chemical substances having plant growth regulating properties and production of bio active compounds such as antibiotics. Microbes acts as bio fertilizer that increases the crop production without polluting the agricultural land. Promoting eco-friendly practices without the use of synthetic and harmful chemicals and majorly based on organic wastes and crop yield with the influence of beneficial microorganisms. Organic farming includes many different techniques such as crop rotation, use of beneficial microbes, weed management involves it also usages of certain microbes as PGPRs that enhances the plant growth and production of crop, playing important role in sustainable agricultural practices.

The term PGPR as beneficial microbes was introduced by Kloepper and Schroth(1978).The term plant growth promoting rhizobacteria means that colonizing the root surface of plant for easy plant development. Rhizosphere is the plant root area where microbes have the highest zone for microbial activity and rich region in nutrients uptake. PGPR acting as potent organisms for sustainable development increasing the crop production without the use of chemicals and pesticides and positive results for controlling the plant diseases caused by harmful pathogens. Now a day's use of PGPR adds environmentally effective yielding crop development by direct or indirect methods. The mechanism of PGPR includes the hormonal and nutritional balance which shows resistance towards plant pathogens and diseases causing pathogens. It solubilizes the nutrient uptake by plants for better growth yield. PGPR shows synergistic and antagonistic effects towards pathogenic microorganisms like fungi and bacteria. PGPR is important agent as biocontrol as well as bio fertilizer. Varity of PGPR such as *Pseudomonas, Bacillus, Klebsilla, Azotobacter, Enterobacter* influencing the crop production. Based on interactions with plants PGPR are cartelized as free living rhizobacteria and symbiotic in nature. The rhizobacteria that live freely outside the plant cells are distinct from those symbiotically associated with rhizobacteria inside the plants. The PGPR works in

both ways direct and indirect way. It increases the efficiency of nitrogen fixing, phosphate solubilizing and various hormonal uptake for plant growth. (Vejan *et al.,* 2016).
(Prasad et *al.,* 2013) direct mechanism of PGPR involves nitrogen fixation, phosphate solubilizing, siderophore production, auxin, gibberline like plant hormones, ACC deaminase. The indirect approach includes techniques likeseveral antibiotics, cell wall degrading enzymes, induced systemic resistance, quorum quenching and siderophore production (Frampton *et al.,* 2012). These methods to control phytopathogens, may be achieved through the use of bacteriophage.

The Direct pathway for auxin synthesis serves as a secondary metabolite promoting plant growth. Auxin naturally occurs in IAA form. Auxin is incorporated in the IAA form. Inactive auxin form including 4-chloroindole-3-acetic acid and various forms combined with sugars, alcohol, amino acids and glycoproteins. Rhizobacterial IAA enhances plant auxin leading to increase surface area and root length.

The existence of ethylene plant hormone symbolizes the importance in regulating of cell development and helping to defect various plant stress level. Ethylene production is influenced by presence and concentration variations of other plant hormones, temperature, gravity, nutrition and stress (Glick *et al.,* 2015). Cytokines are wide spread in algae, bacteria and higher plants, being generated in the root tips and subsequently transported through xylem to the shoots. It induces the shoot length and root development for better plant yield (Martinez *et al.,* 2016).

Organism such as bacteria and plants, rely significantly on nitrogen as a crucial nutrient for their growth. Directly atmospheric nitrogen is not able to fix in soil thus requires to convert into ammonia and nitrates. Bacteria with the ability to solubilize phosphate are identified as phosphate solubilizing bacteria. It supplies phosphate in simpler form and not damaging the environment. It converts soluble organic and insoluble organic phosphate which can easily consumed by plants. Inorganic phosphate solubilizing uses mineral dissolving ions and compounds like organic acids, proteins, siderophore and CO_2 (Rodríguez and Fraga 1999). Organic materials in the form of phytate represent the primary source of organic phosphorus in soil. Phosphorus mineralization means solubilizing organic phosphorous and degrading other molecules.

Siderophore are peptide molecule with a side chain and functional group to which the ferric ion binds. Those act as ion chelators showing higher efficiency towards ligand. Siderophore producing microbes prevents pathogenic propagation by reducing the amount of ion. PGPB prevents propagation of phytopathogens by siderophore production with high affinity towards ions. Pathogens are unable to propagate due to lack of iron and causing them to lose the ability as pathogen (Kloepper *et al.,* 1980).

Raaijmakers and Mazzola (2012) reported indirect method involving antibiotics to control pathogens and preventing plant damage. They generate a range of metabolites including antifungal, antimicrobial, phytotoxins and antioxidants. Cell wall degrading enzymes includes chitinase that degrade chitin, proteases that degrades proteins, and lipase that degrades cell wall associated lipids. All of which individually degrades fungal cell (Friedrich *et al.,* 2012). Furthermore, plant associated plant enzymes, some biocontrol PGPB synthesis similar cell wall degrading enzymes. Some phytopathogens are lysed by some rhizobacteria. To kill plant pathogen bacterial culture suspension are sprayed onto the infected plants as a mixture of different bacteriophage strains.

Thus, in the present investigation to find out the plant growth promoting rhizobacteria from soil samples that having the property to reduction of phytopathogens, employed as plant growth promoters it can also nurture soil health too.