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BENEFICIAL MICROBES IN AGRICULTURE: SYMBIOSIS FOR SUSTAINABLE SOIL MANAGEMENT AND CROP PRODUCTION IN CHANGING CLIMATES

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Soil fertility and health is continuously declining due to removal of essential plant nutrients from the soils in the current changing climate scenario. Low and high water and temperature stresses results in the deficiencies of essential plant nutrients, organic matter and beneficial soil microbes that had negative impact on soil health, crop productivity and grower's income especially under arid and semiarid climates globally. Integrated nutrients management in arid and semiarid climates increase soil fertility and health, increase crop productivity and grower's income. Integrated nutrients management refers to the maintenance of soil fertility and improvement in crop productivity with application of plant nutrients through combined application of organic manures, inorganic/chemical fertilizers and bio-fertilizers (beneficial microbes). Beneficial microbes are known to play several vital roles in soil fertility; crop productivity and profitability. Bio-fertilizers are the prod¬ucts containing living cells of different types of beneficial microbes (bacteria, fungi, protozoa, algae and viruses). Some of the commonly used beneficial microbes in agriculture include Rhizobia, Mycorrhizae, Azospirillum, Bacillus, Pseudomonas, Trichoderma, Streptomyces species etc. Beneficial microbes are essential for decomposing organic matter in the soil and increase essential macro-nutrients (nitrogen, phosphorus, potassium, sulfur, calcium and magnesium) and micro-nutrients (boron, copper, chlorine, iron, manganese, molybdenum and zinc) availability to crop plants. Beneficial microbes also play significant role in solid wastes and sewage management. Beneficial microbes increase plants tolerance to different environmental stresses (drought, heat, cold, salinity etc.) and increase plant resistance to insects and diseases attacks. Beneficial microbes not only improve crop growth and productivity by increasing photosynthesis and producing hormones and enzymes, but also improve crop quality by controlling different insects and various plant diseases. Beneficial microbes reduce the use of chemical fertilizers and thereby reduce environmental pollution caused by chemical fertilizers. Beneficial microbes reduce cost of production and so increase grower's income and profitability. Beneficial microbes are therefore very important for increasing crop productivity, profitability and sustainability. Applications of organic manures such as crop residues, animal manures, chicken manures, green manures, composts, farm yard manure, biochar, ash etc. increases the beneficial microbes in the soil and improves soil health and sustainability. Our long-term field experiments on field crops e.g. cereals crops (rice, wheat & maize), oilseed crops (canola, sunflower & soybean) and grain legumes/pulses (chickpea, mungbean & mashbean) confirmed a significant increase in yield per unit area with integrated nutrients management under semiarid climate in Peshawar Valley. The combined application of plant nutrients especially major nutrients (nitrogen, phosphorus and potash) along with different organic sources (farmyard manure; animal manures: poultry manure, cattle manure, sheep manure, goat manure etc., plant residues: onion residues, garlic residues, wheat residues, rice residues, chickpea residues, fababean residues, canola residues etc.) into the soil plus application of beneficial microbes had significantly improved crop growth and increased productivity and profitability.

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