Potassium solubilizing bacteria: A solution for improving potassium status in soil

Pooja Choudhary and Anaytullah Siddique*

School of Agriculture, Department of Agronomy, Lovely Professional University, Phagwara, (Punjab), 144411, India

ABSTRACT:

Potassium is one of the 3rd most essential elements for the plant growth and development after nitrogen and phosphorus while 7th most abundant element in the earth crust. It present in more than enough amount in soil but because of bound from, plants are unable to absorb through roots to perform their functions properly therefore to fulfill the demand of potassium for plant, inorganic base fertilizer need to apply in the soil. The wide range of microbes present in the soil / rhizospheric zone of plants roots which play a vital role in favour of solubilizing or mobilizing the bound form of potassium present in the soil hence plant can absorb and further use for the activation of enzymes, partial closing of stomata and regulation of stress related function. Wide ranges of potassium solubilizing bacteria are available in the market with varying potential known as KSM like Bacillus species (*B. mucilaginosus, B. edaphicus,* and *B. circulans*), *Acidothiobacillus ferrooxidans*, Cladosporium, Sphingomonas, Aminobacter are known to improve potassium status in the soil by solubilisation and mobilization process without causing any pollution and hazard in the soil.

KEYWORDS: Potassium, KSB, KSM, Stress, growth and development.

INTRODUCTION:

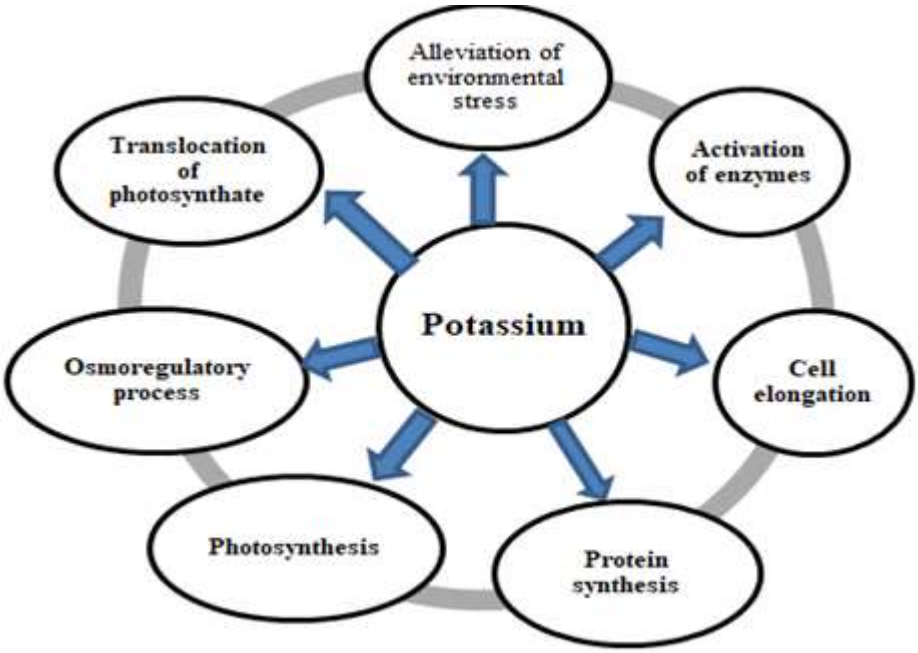
The biofertilizers are well known with respect to crop production and soil fertility as it provide natural environment as well as provide essential nutrients to the crops. It has been observed that inoculation of two or more biofertilizers is found more effective than single thus the demand of biofertilizers is increasing day by day. Potassium is denoted by letter K which comes from the German word Kalium. It is a macronutrient which is required by plant for performing multiple functions in the plant during growth and development like activation of enzymes, partial closing of stomata and regulation of stress related function (Bhardwaj *et al.*, 2014 and Choudhary and Siddique, 2021). There are four major source of potassium present in the soil i.e. soil minerals, non-exchangeable potassium, exchangeable and organic matter. Out of these source, two major source of potassium present in the soil i.e. feldspar and mica that contains about 90-98% of potassium. However, non-exchangeable and exchangeable form of potassium contains about 1-10% and 1-2%. Due to bound from of major source of potassium in the soil, plants cannot utilize it efficiently (Prajapati and Modi, 2012 and Rehm and Schmitt, 2002). A wide range of microbes present in

the soil / rhizospheric zone like *Bacillus species* (*B. mucilaginosus, B. edaphicus,* and *B. circulans*), *Acidothiobacillus ferrooxidans*, *Cladosporium, Sphingomonas* and *Aminobacter* have an ability to transform the bound form of potassium in to solubilize form through well-known mechanism i.e. acidolysis, chelation, complexolysis and exchange reactions (Etisami *et al.,* 2017; Shrivastava *et al.,* 2016 and Ahamad *et al.,* 2016).

Physiological and biochemical functions of potassium

Potassium is not a part of chemical structure of plant; it plays many vital roles for regulation of growth and development of through a series of physiological and biochemical reactions. A large number of enzyme activities depends directly or indirectly on the amount of potassium present in plant cell because presence of enough amount of potassium in to the plant cell help to maintain the pH range between 7-8 which is most suitable condition for enzymatic reactions within the plant (Van Brunt and Sultenfuss, 1998). Potassium is responsible for partial closing of fine pore present on leaf surface hence water use efficiently increases under normal as well as adverse environmental condition. Proper functioning of stomatal also coordinate well with other processes like osmosis, diffusion, water and nutrient uptake, photosynthesis and thermal cooling, water and nutrient transport. Translocation of nutrient like NO_3, phosphates, Ca, Mg and amino acids is also affected due to the deficiency of K. Therefore satisfactory amount of potassium supply in the soil is compulsory to regulate the translocation of water and nutrient through xylem. Due to deficiency of potassium, the process of protein synthesis inhibited even though the nitrogen is available in enough amounts because protein synthesis is catalyzes by a specific enzyme nitrate reductase while K is responsible for activation of nitrate reductase enzyme, Starch synthesis catalyzed in the presence of enzyme starch synthetase however, potassium is one of the key element that require activating the starch synthetase. As the concentration of K decreases, the amount of starch decline while the production of soluble carbohydrates continue.

Specific functions of potassium in plant



Potassium solubilizing bacteria (KSB) in soil:

Fertility of soil can be defined as the capacity of soil to supply nutrients to the plant but most of the time these minerals are present in bound form. Adequate amount of potassium present in the soil that is enough to fulfilling the demand of plant for smooth functioning of biochemical reactions but these amount of potassium is present in bounded form hence plants are unable use it. There are many species of microbes present in the soil as well as near by rhizosphere of plant has the capacity to convert this unavailable form to available form (Etesami *et al.,* 2017 and Zhao *et al.,* 2016). There are four major form of bound potassium present in the soil i.e. fixed K, Structural K, Exchangeable K and soil solution K. Potassium solubilizing bacteria (KSB) ac on these kind of potassium to release usable form of potassium by different reactions like organic and inorganic production, chelation, acidolysis and complexolysis are the major process (Maurya *et al.,* 2014; Meena *et al.,* 2014 and Etesami *et al.,* 2017). Decomposed organic matter produces acids like citric acid, formic acid, malic acid and oxalic acid. These acids accelerate the process of dissolution of potassium compound by providing proton and complexing Calcium + ions. Potassium solubilisation process occurs by the formation of complex between organic acid and ions like Fe^{2+}, Al^{3+} and Ca^{2+}. In addition to this, KSB can promote the weathering process of K minerals especially when it comes in direct contact with mineral surfaces. Specific strain of KSB like *Bacillus pseudomycoides* enhance the K from mica waste soil and *Bacillus cereus* enhance K from feldspar (Fasusi *et al.,* 2021; Ali Ahamad *et al.,* 2016 and Pramanik *et al.,* 2019).

CONCLUSION:

Potassium is one of most essential nutrient required by plant in greater quantity for proper physiological and biochemical reaction to facilitate growth and development as it has various vital roles in plant. To fulfill the demand of potassium fertilizer, we are completely depending on foreign import. However KSB present in rhizospheric zone of plants are capable to solubilize unavailable form to available form via various processes which are helpful to improve the availability of K in soil, hence it can be consider alternative option of chemical fertilizers.

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