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Potassium Salt of Active Phosphorous (PSAP); An Innovative Bioactive P and K Fertilizer cum Elicitor Molecule in Improving Growth, Yield, Quality and Climate Resilience of Crop Plants.

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ABSTRACT

Plants require conditions of balanced plant nutrition to realize its maximum genetic potential. A pre-determined ratio of nutrients is more critical than actual concentration of the individual elements. Two or more elements working together to create an overall improved physiological state in plants is called physiological synergism which is an important concern of nutrient use efficiency. Phosphorus(P) and Potassium (K) are an essential elements for carrying essential plant physiological functions and also serves an adaptive significance under various environmental cues. The first imbalance that needs to be corrected in the present day agriculture is the undying love for nitrogen as a fertilizer. PSAP is a research molecule designed and developed to cater to the need of crop plants and the mode of its application helps to satisfy the P and K demand at critical growth stages and to significantly improve nutrient use efficiency in general and nitrogen use efficiency in particular. The key to invention of PSAP is the need of the farming community of efficient and timely phosphorus availability by overcoming the soil fixation and other transformation barriers and the activated phosphorus and potassium combination in PSAP helps them readily available.

Phosphorus occurs in many forms within the plants like phosphorylated sugars, proteins, nucleic acids(DNA and RNA) and lipids but its vital function is enabling energy transfer through formation of ATP. Phosphorus demand is driven by the energy demands of photosynthesis (Ghannoum *et al,* 2008) and the quantity of P required for ATP and RNA are relatively small to maintain maximum rates of carbon capture(Bingham F.T., 1966). Potassium(K) mainly functions like a conveyer of electrical charge in the plant cell and acts as catalysts for many of the enzymatic processes and is also has critical role to play in redox and ion homeostasis, osmoregulation, stomatal opening and closing, oxidative phosphorylation and quality improvement and extending shelf life of farm produce. Potassium interactions with nitrogen (N) are well documented and plants deficient in potassium will not produce proteins despite an abundance of available nitrogen. Potassium has direct synergistic relationships with iron(Fe) and manganese(Mn) which are important component of photosynthesis, chlorophyll, ferrodoxin an essential component of oxidation/reduction reactions like nitrate and sulphate reduction and nitrogen fixation (Malvi-RanadeU, 2011) Potassium enhances antioxidative defense and helps to scavange ROS and provide cell signaling alone or in combination with phytohormones (Hasanuzzaman *et al.*,2018)

PSAP is highly soluble in water with neutral pH and gets readily absorbed by foliage without any phytotoxic effects. The activated phosphorus and potassium helps the nice coordination of two important cell organelles chloroplast and mitochondria in exchanging reducing equivalents from chloroplast to mitochondria and avoiding over reduction of the chloroplast and photoinhibition and export of ATP from mitochondria to chloroplast for fine tuning of photosynthesis. Fertilizer P applied to the soil is rapidly immobilized by soil processes and therefore modifying

fertilizer formulations to inhibit P complexation modifying application methods for more precise targeting of P to the plant to satisfy crop P requirement during critical growth phases is the call of the present situation and "feed the crop not the soil" is a rethinking for phosphorus management (Withers *et al,* 2014). PSAP design, development and the mode of its application is a way forward for improving yield and quality and for climate smart agriculture. PSAP helps to improve P use efficiency and therefore adoption of PSAP technology will need to be integrated with investments in crop breeding programmes. PSAP technology if successfully integrated will result in controlled depletion of excessive P in soils with reduced eutrophication risk.

Use of PSAP over the past decade in different crops viz. grapes, sugarcane, soybean, onion, mango and across the agroclimatic zones by ICAR institutes and State Agricultural Universities, progressive farmers have reported substantial improvement in yield, quality and tolerance to biotic and abiotic stresses. PSAP technology is an indispensable component of those farmers who have used this in their crop production program. The knowledge of the nutrient synergism of P and K in PSAP helps to boost yield and fertilizer use efficiency as reported earlier (Rietra *et al.,*2017). The N-P and N-K interactions effects are well documented at physio-biochemical and molecular levels in plants. PSAP treated plants will provide a platform to decipher the P-K interactions at transcriptional and metabolomics levels.

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