

Importance of Polyhalite Fertilizer

Kannappan M¹, Vasanth P² and Nivetha K¹

¹M.Sc. Researcher, ²Ph.D. Scholar, Department of Agronomy, Faculty of Agriculture, Annamalai University, Chidambaram – 608 002, Tamil Nadu, India.

Corresponding Author: kannappanvikram29@gmail.com

Polyhalite fertilizer (fig. 1) is gaining significant attention as a valuable multi-nutrient source to improve crop yield, quality, and sustainable agricultural practices. Below is a comprehensive, well-structured article explaining the importance of polyhalite fertilizer in agriculture, covering its composition, benefits, applications, and environmental impact.

Understanding Polyhalite: A Natural Multi-Nutrient Fertilizer

Polyhalite is a naturally occurring mineral composed mainly of potassium (K), magnesium (Mg), calcium (Ca), and sulphur (S) in balanced proportions. Its chemical formula is $K_2SO_4 \cdot MgSO_4 \cdot 2CaSO_4 \cdot 2H_2O$. These four nutrients are essential for healthy plant growth and development, making polyhalite a unique multi-nutrient fertilizer.



Fig. 1 Polyhalite fertilizer

Potassium (K) plays a critical role in water regulation, enzyme activation, and photosynthesis. Magnesium (Mg) is vital for chlorophyll production and enzyme function. Calcium (Ca) strengthens plant cell walls, enhancing structural integrity, and sulphur (S) is essential for protein synthesis and enzyme activity. The combination of these nutrients in polyhalite addresses multiple crop nutritional needs simultaneously.

Why Polyhalite Fertilizers Are Important in Modern Agriculture

1. Addressing Nutrient Deficiencies

Over recent decades, soils worldwide, especially in regions like Europe, the US, southern China, and tropical climates, have shown deficiencies in sulphur, magnesium, and calcium apart from potassium. This deficiency results from declining atmospheric sulphur deposition and intensive cropping systems depleting soil nutrient stocks. Polyhalite supplies all these nutrients in one single application, simplifying fertilization plans and improving soil nutrient balance.

2. Slow-Release and Efficient Nutrient Supply

Unlike some soluble fertilizers that release nutrients rapidly and are susceptible to leaching, polyhalite has a slower dissolving rate. It gradually provides nutrients, which reduces nutrient losses, leaching into groundwater, and enhances nutrient use efficiency by crops. This slow-release characteristic means nutrients remain in the root zone longer and are more available during critical growth stages.

3. Improved Crop Yield and Quality

Field trials and research on various crops such as corn, barley, sugarcane, tea, black pepper, lettuce, peanut, potato, and cabbage have demonstrated that polyhalite applications enhance crop yields substantially.

For example: Corn and barley showed yield increases ranging from 15% to 135% when polyhalite was added to common NPK fertilizer plans.

Sugarcane treated with polyhalite had higher sugar purity and commercial cane sugar content, with quality attributes like brix, pol, and extraction percentage improved over conventional potash fertilizers.

Tea plants fertilized with polyhalite exhibited increased biomass and enhanced quality components, including significantly higher amino acid content, which improves tea taste.

Black pepper grown on acid soils had improved vine strength, better resistance to mealybug

attacks, and higher yield and quality with polyhalite combined with potassium chloride.

Other crops, such as lettuce in soilless culture and peanuts in China, benefited from balanced nutrient supply, affecting biomass growth and nutrient content positively. The simultaneous supply of potassium, magnesium, calcium, and sulphur improves various plant physiological processes, increases nutrient uptake, and enhances tolerance to pests and diseases.

4. Environmental and Soil Health Benefits

Chemical fertilizers, while boosting crop productivity, have raised concerns about adverse environmental impacts, such as soil degradation, groundwater contamination, and loss of soil biodiversity. Polyhalite, being a natural mineral with slow solubility, reduces the risk of nutrient runoff and leaching, promoting sustainable soil management. It supports soil structure by supplying calcium, which improves soil aggregation and water retention.

Using polyhalite can partially replace conventional potash fertilizers, reducing reliance on mined potash salts like potassium chloride, which may contain chloride ions harmful to some crops and soils over time. Its balanced nutrient profile helps prevent nutrient imbalances that degrade soil fertility.

5. Wide Crop and Soil Adaptability

Polyhalite has demonstrated effectiveness in a variety of crop types field crops (corn, barley, wheat), horticultural crops (tomatoes, lettuce, cabbage), and plantation crops (tea, sugarcane, oil palm, black pepper) across different soil types including acidic, sandy, and tropical soils. This versatility makes polyhalite an excellent fertilizer choice for many agricultural systems globally.

The Science Behind Polyhalite's Nutrient Release

Laboratory and field studies confirm that the release of potassium, magnesium, calcium, and sulphur from polyhalite occurs at varying rates depending on environmental conditions such as temperature, soil moisture, and irrigation management. Potassium and magnesium dissolve relatively quickly, while calcium releases more gradually, ensuring prolonged availability.

The mineral's slow dissolution decreases the risk of secondary crystal formation commonly seen in highly soluble salts, which improves nutrient

availability for plants over extended periods. Furthermore, studies show that the leaching of nutrients such as calcium and potassium from polyhalite is lower than with soluble sulphate fertilizers, reducing nutrient loss.

Enhancing Fertilizer Efficiency and Farmer Profitability

The inclusion of polyhalite in fertilizer plans not only boosts nutrient efficiency but also improves farmer profitability by potentially reducing the quantity of fertilizer required for target yields. Several trials indicate that polyhalite formulations can achieve equal or better crop yields compared to conventional NPK blends, sometimes allowing reduced fertilizer rates due to its multi-nutrient supply and slower nutrient release.

In crops like sugarcane and black pepper, polyhalite use correlates with increased crop quality, which commands better market prices. Enhanced quality traits include higher sugar purity in sugarcane and better pest resistance in black pepper, translating into economic benefits for growers.

Practical Applications and Usage Recommendations

Application Rates: The optimal polyhalite fertilizer dose depends on crop type and soil nutrient status. Recommended rates vary typically between 500 and 2500 kg per hectare, adjusted according to potassium, calcium, magnesium, and sulphur needs.

Combination with Other Fertilizers: Polyhalite is often blended with other fertilizers such as nitrogen (N) and phosphorus (P) sources to form balanced fertilizer plans. It is also effectively combined with potassium chloride for supplemental potassium supply.

Suitability for Different Agricultural Systems: It can be applied in conventional soil-based systems and hydroponics or soilless culture, as demonstrated in lettuce production trials where it supplied potassium and calcium efficiently.

Challenges and Future Perspectives

While polyhalite offers many benefits, some challenges include:

- **Solubility Limitations:** Calcium components in polyhalite dissolve more slowly, which might not meet immediate crop needs in some cases and might require complementary fertilization.

- **Cost Considerations:** The initial cost of polyhalite fertilizer can be higher than traditional potassium fertilizers, which may impact adoption unless balanced by yield and quality improvements.
- **Long-term Impact Studies:** Extended research on perennial crops and diverse agro-ecosystems is needed to fully understand polyhalite's effects on crop production and soil health over time.

Future research should focus on optimizing polyhalite application methods, integration with organic and nano-fertilizers for sustainable farming, and broader environmental impact assessments.

Conclusion

Polyhalite fertilizers are a promising natural solution to meet the increasing demands for balanced crop nutrition, improved yield, and sustainable agriculture. By supplying essential nutrients potassium, magnesium, calcium, and sulphur-in natural, slow-release forms, polyhalite enhances nutrient efficiency, improves crop quality, and supports soil health. Its application across various crops and regions highlights its potential as a cornerstone in modern fertilization strategies that align productivity goals with environmental stewardship.
