

## Overcoming the barriers of utilization of mica waste as a potassic fertilizer

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*Mica waste generated after cleaning and processing mica ore contains about 8–10% potassium (K). Its potential as an alternative to costly potassic fertilizers is currently being exploited, especially in India, where the entire demand for K fertilizers is met through imports. Suitable modifications of mica waste by chemical and biological means may prove to be an agricultural resource. However, its practical utilization is obstructed by certain challenges, as discussed here, which need to be addressed in order to reduce India's dependency on imports of K fertilizers and take a step forward towards a self-reliant India.*

Considering the fact that using of fertilizers in agriculture is indispensable, the next thought that comes to our mind is its availability, which ought to be both accessible and economical. When the cost of fertilizers is taken into account, commercial potassic (K) fertilizers like muriate of potash (KCl) or sulphate of potash ( $K_2SO_4$ ) are one of the costliest fertilizers. It is because there are no deposits of high-grade K-bearing minerals in India to manufacture K fertilizers.

India has enormous deposits of low-grade K-bearing minerals like mica, glauconite, etc. This article shall be limited to the potentialities of mica waste. White mica, which is a chemically muscovite mineral ( $KAl_2(AlSi_3O_{10})(OH)_2$ ), has been reported to contain about 8–10% of K, but its potential to be used as K fertilizer is still underway. Mica mineral is comprised of not one mineral but a group of 34 phyllosilicate minerals that exhibits layered or platy structure. Out of different mica, muscovite (potash or white mica) and phlogopite (amber mica) are commercially important from an industrial point of view. Muscovite mineral is imbued with elasticity, toughness, flexibility, and transparency with high heat resistance and dielectric strength. Due to its unique properties, mica minerals find applicability in electrical industries as an insulator, capacitor, etc. Besides, mica is used in paint, rubber, and plastic as filler and reinforcer. Mica in small quantities is also employed for cosmetic applications<sup>1</sup>. However, all these uses of mica are restricted to industries, and its applicability in the purview of agriculture is an entirely new area and needs research attention. Recently, research has been conducted to explore the potential of mica mineral as a source of K fertilizer.

Mica deposits are abundant in Andhra Pradesh, Bihar, Jharkhand, Maharashtra, Odisha, Rajasthan, and Telangana. It is also

reported to be available in the pockets of Gujarat, Haryana, Kerala, Tamil Nadu and West Bengal. According to the database of the National Mineral Inventory–Indian Bureau of Mines, a total of 635,302 tonnes of mica was estimated in India in 2015. Andhra Pradesh leads with a 41% share of the country's total resources, followed by Rajasthan (28%), Odisha (17%), Maharashtra (13%), Bihar (2%), and a small quantity of resources is found in Jharkhand and Telangana<sup>1</sup>. Data suggests that though India lacks high-grade K-bearing minerals, it is fortunate to have huge deposits of low-grade K-bearing minerals.

About 2/3rd of mica is discarded as waste during the cleaning and processing of mica and has no practical utilization. Attempts have been made to utilize this untapped resource in agriculture as K fertilizer by using it directly in soil or through suitable chemical and biological modifications, highlighting its immense potential for an alternative source of costly K fertilizers in the Indian context. However, using mica waste as K fertilizer is associated with certain challenges that need immediate attention.

Any new idea that seems to minimize our economic burden appears alluring initially. However, it comes wrapped up with certain challenges, some of which are discussed in this section. (i) The biggest challenge in using mica as commercial K fertilizer is its continuous availability. Fertilizer requirement in agriculture is predicted to increase with time as the nutrient status of the soil gradually declines. In this regard, it is essential to understand other engagements of mica minerals as they cannot be taken up at the cost of hampering our industries. (ii) The recovery rate of K from mineral sources such as mica has been reported to be minimum as K is present in highly insoluble forms in such minerals. If the recovery rate or K use efficiency is insufficient to meet the crop requirements, such

ideas shall prove to be more of a burden than a boon. (iii) It has been reported that the smaller the size of mica particles, the better will be the efficiency<sup>2</sup>; however, application in powder form alleviates the cost of preparation, and this might reflect in the overall cost of inputs. (iv) Use of mica minerals has not been studied with respect to the manifestation of any adverse effects on plant growth, and this needs to be addressed.

It has been rightly said that challenges are opportunities in disguise. Using mica as fertilizer can be highly profitable if taken in the right direction. Some ways to overcome the pertinent challenges are discussed here. (1) Regarding the availability, the deposits are pretty high in India, but before finding its possibility in agriculture, it also has to be made sure that these industries do not suffer in the event of mica being diverted towards agriculture. Therefore, in this regard, it is also essential to have a substitute for mica. It is possible to substitute mica with materials like alumina, ceramics, bentonite, glass, fused quartz, silicon, talc, bakelite, nylon synthetic mica, acrylate polymers, cellulose acetate, fibreglass, etc<sup>1</sup>. Some lightweight aggregates, such as diatomite, vermiculite and perlite, may be substituted for ground mica when used as filler. (2) In order to improve the recovery rate, it has been suggested by many researchers that the recovery rate can be increased if waste mica is modified by chemical or biological means. The use of K solubilizing bacteria (KSB) has been known to improve K release from mica by producing organic acids that directly dissolve mineral K or bring K into solution form. They are also known to secrete exopolysaccharides which further improve the concentration of organic acids and increase their efficacy. The recovery rate after using different KSB has been reported to improve by 25–50% (refs 3, 4). This saving of muriate of potash should be

monetized, and the overall cost worked out to get a clear picture. (3) Chemical treatment of mica is costly, so the focus should be primarily on biological improvement. (4) The application can be made simple and if it is manufactured in the form of a product with a recommended dose of waste mica and an adequate population of KSB imbibed together in a ready-to-use package. (5) There is much research that claims that mica mineral can be considered a potent fertilizer. However, the exact recommendation regarding the proportions of mica and commercial fertilizer to be used needs to be worked out, so as to not compromise with yield benefits. (6) Research needs to be directed towards more field experiments which shall further bring out difficulties encountered at the field level. Also, there are prospects in identifying any nega-

tive impacts due to the use of these minerals at a large scale. (7) Upscaling the use of mica fertilizer can be taken up locally, i.e. in areas where these mines are located. This will further reduce the cost of transportation and minimize the input cost.

Reducing the dependency on costly K fertilizer using indigenous minerals like mica waste can be revolutionary. This shall play a vital role in boosting Indian agriculture and the economy. It is the need of the hour that researchers direct their energy and expertise to produce ready-to-use fertilizer material. This will minimize India's dependency on commercial K fertilizer and lead the road towards a self-reliant India.

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