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POLY4: A Multi -Nutrient Fertilizer – Suitability for Organic Farming

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Abstract

Fertilizers are the critical inputs in agriculture and their use is increasing day by day. The need of the hour is therefore, maximizing the production with sustainability. Indiscriminate use of N-based fertilizers led to the deficiency of other macro and micronutrients, greenhouse emissions, soil and water pollution. Now a days, the fertilizers manufactured with low carbon foot print and from natural or mineral sources are gaining popularity. Among many, polyhalite (POLY4) has been identified as a multi-nutrient fertilizer and it is obtained from mineral ore containing polyhalite (K_2SO_4.$MgSO_4$.2$CaSO_4$.2H_2O), which is known to improve yields in different crops. Furthermore, it can also be used as an organic multi-nutrient fertilizer as it is obtained directly from mineral source without any chemical process. However, the information on uses and benefits of polyhalite is meager hence an attempt has been made to compile and synthesize available information for the benefit of all the stake holders.

1. Introduction

Overusing of nitrogen-based fertilizers resulted in a shortage of other vital macro and micro nutrients. Rising global population, the growing need for diets rich in protein, and a reduction in available agricultural land have resulted in increased costs for fertilizers due to the heightened Worldwide demand for various essential nutrients. Hence, use of multi-nutrient fertilizer is mandatory in intensive agriculture to ensure and sustain an adequate supply for crops (Zorba et al., 2014). In recent years, multi-nutrient fertilizers have gained popularity particularly in soils that have low fertility levels. Polyhalite (POLY4) is such type of multi-nutrient fertilizer which supplies four major nutrients at a time. It is a natural combination of four (K, S, Mg and Ca) of the total six essential macronutrients required for growth and development of plants. POLY4 contains 14% K_2O, 17% CaO, 6% MgO and 19% S. It is obtained from

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polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$), a potassium-bearing mineral in North Yorkshire, United Kingdom, has the highest quality POLY4 (85.7% pure) (Kemp et al., 2016 and Albadarin et al., 2017). High-grade polyhalite can be mined and marketed with no processing except crushing and sizing, which has sparked interest in its use as a low-chloride potassium fertilizer. Literature on polyhalite fertilizer application to agronomic crops is very limited. Polyhalite has been shown to perform well as a fertilizer of rice, ramie, peanut, potato, and corn, with equal or greater yields and improved quality compared to the use of muriate of potash (MOP) and sulfate of potash (SOP). Tiwari et al. (2015) demonstrated that application of polyhalite fertilizers increased mustard and sesame yields and significantly increased the absorption of potassium by plants compared with other fertilizers. Da Costa Mello et al. (2018) reported that soils treated with polyhalite fertilizer had higher Ca and Mg contents compared to those treated with other fertilizer. These results indicate that POLY4 could serve as a K fertilizer in agriculture.

2. POLY4 as Multi-Nutrient Source

✓ POLY4 includes four of the six key macro nutrients that all plants need to grow: potassium, sulphur, magnesium and calcium (Figure 1) and nutrient content were given in table 5.

✓ Sirius Minerals Plc, Scarborough, United Kingdom, a company formed to develop and market the new fertilizer, has started to commercially produce a granulated version of polyhalite with the trade name POLY4.

✓ The granulated fertilizer, POLY4, has a relatively low salt index compared to other potassium fertilizers such as MOP or SOP (Barbier et al., 2017).

✓ POLY4 is low in chloride, suitable for organic farming and supplies nutrition to crops from planting to harvest.

3. Scope for Use of POLY4 in India

Soils are recognized as lacking in sulphur and magnesium. The current subsidy system encourages excessive application of nitrogen. Indiscriminate use of these fertilizers causes the deficiencies of other macro and micro nutrients. To correct these deficiencies use of multi-nutrient fertilizer should be the best approach. Inclusion of POLY4 in fertilizer plans offers a viable solution delivering potassium, sulphur and magnesium in one product while improving nutrient-delivery profile.

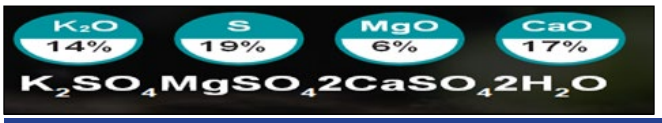

Figure 1: Nutrient composition of POLY4

4. POLY4 Production Process

❖ POLY4 delivers four of the six essential macro nutrients and a wide range of micro nutrients fused in one granule.

❖ POLY4 produces no waste and requires no chemical processing with a 1:1 polyhalite ore-to-product ratio.

❖ It is produced by mining from polyhalite ore followed by crushing and grinding the mineral and then granulating the resulting powder using a starch binder under a patented process (Figure 2).

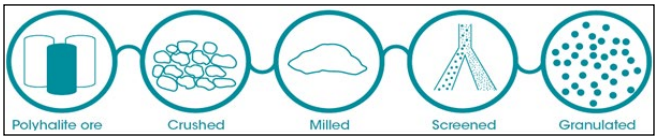

Figure 2: POLY4 production process

5. POLY4 Product Characteristics

The characteristics of POLY4 for its suitability as multi-nutrient fertilizer are detailed below in table1.

Table 1: Characteristics of POLY4 fertilizer

Sl. No.	Character-istics	Remarks
1	Nutrient content	POLY4 contains 14% K_2O, 19% S, 6% MgO and 17% CaO (Figure 3) which is most commonly expressed as a percentage by weight.
2	Solubility	POLY4 has a solubility of 27 g L^{-1} at 25°C, which corresponds to the amount of POLY4 that would dissolve in the plough layer of a moist, medium textured soil at a 10 t ha^{-1} application rate (Figure 4).
3	Dissolution rate	Dissolution is the rate of phase-change from solid into solution.The fertilizer industry uses artificial barriers to control dissolution rate. POLY4's natural dissolution rate effectively regulates release of nutrients to crops without the need for artificial barriers (Figure 5).

Sl. No.	Characteristics	Remarks
4	Nutrient delivery	With four of the six macro nutrients (K, S, Mg and Ca), fertilizer plans that include POLY4 deliver a better outcome because of greater nutrient release based on crop demand as well as improved soil structure (Figure 6).
5	Low carbon footprint	POLY4 has a low CO_2 emission and is more environmentally-friendly than most fertilizer products and potassium fertilizer sources (Figure 7). POLY4 production generates only 7% CO_2 relative to SOP and 15% CO_2 relative to MOP.
6	Fertilizer use efficiency	POLY4 promotes the nutrient release, enabled and supported a broad spectrum of macro and micro-nutrient uptake, creating a favorable nutritional support for crop production (Figure 8).
7	Particle size	POLY4 granules are manufactured within 2 mm to 4 mm (5-10 mesh) consistent grade pattern – optimal for agronomic performance, storage, handling, spreading and blending.
8	Crush strength	POLY4 has crushstrength of 6.5 kgf – optimal for handling, distribution and field application.
9	Relative humidity (RH %)	POLY4 has an RH of 70% similar to other fertilizers. Attracting less moisture is important for lowering caking propensity and increasing shelf life.
10	Compatibility in blends	POLY4 is a compatible input for blending in NPK fertilizers and can be manufactured in dry blends or compacted, steam-granulated and chemical compounds (Figure 9).

Source:Anonymous, 2020b

6. Cost of POLY4 and Availability

❑ Based on 2017 average values, the full component value price for polyhalite would have been under USD200 t^{-1} at export.

❑ POLY4 is presently not available in market. Sirius Minerals is manufacturing polyhalite in the form of granules and marketing it worldwide as POLY4. Sirius Minerals want to market this product with the tie up of

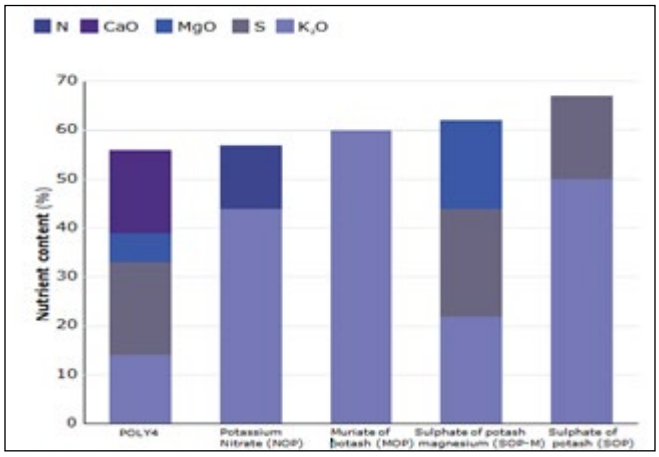

Figure 3: Nutrient content of major potash fertilizers

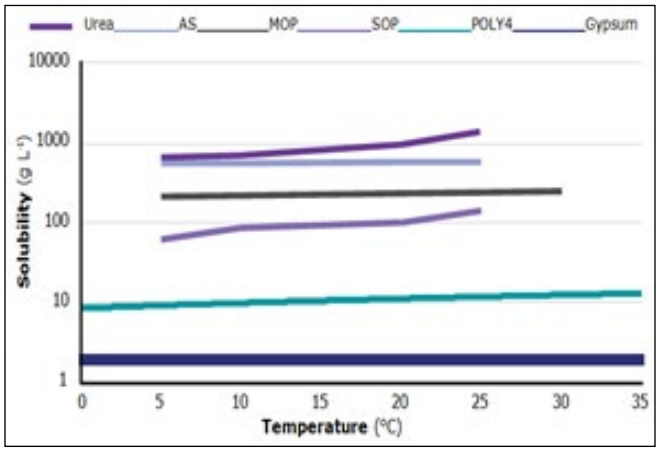

Figure 4: Solubility (g L^{-1}) of POLY4 in water over a range of temperatures compared to other commercial fertilizers

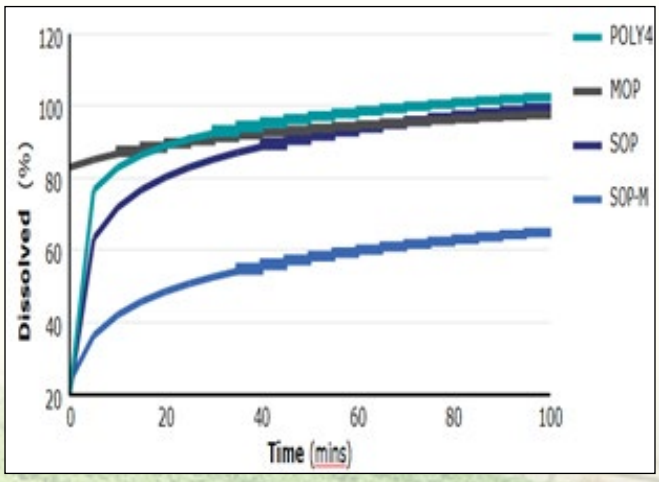

Figure 5: Dissolution of granular POLY4 in water over time compared to other potassium-based fertilizers

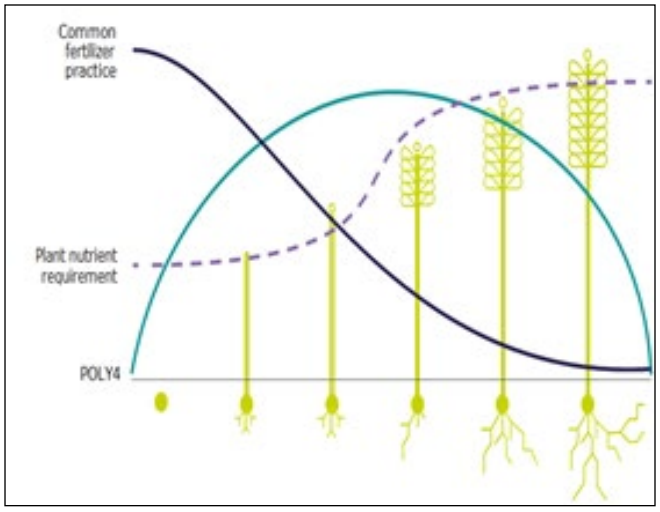

Figure 6: Nutrient delivery nature of POLY4

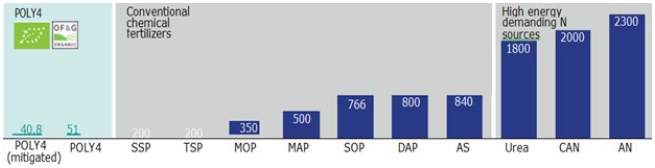

Figure 7: CO_2 emissions of POLY4 in comparison to other fertilizers

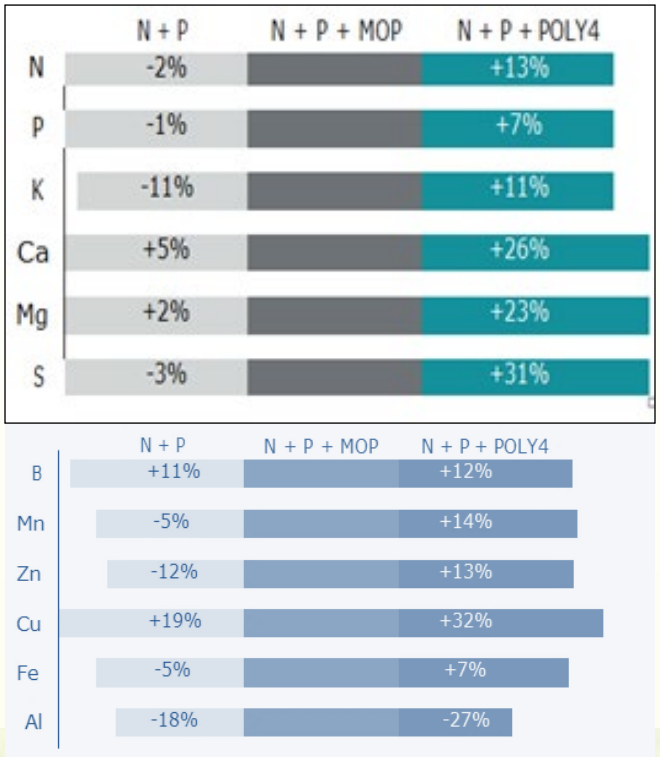

Figure 8: Macro and micro nutrients uptake using POLY4 and MOP

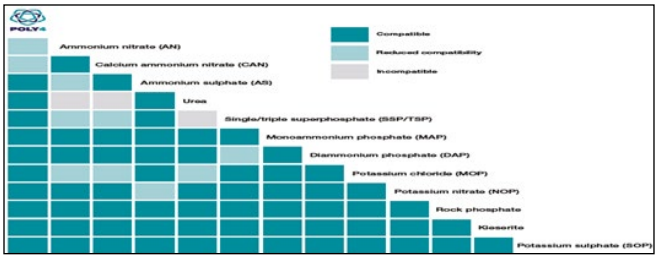

Figure 9: Compatibility of POLY4 with other fertilizers

IFFCO- Indian Farmers Fertilizer Cooperative Limited through the research trials. The provisional cost was given by Sirius minerals for POLY4 is Rs. 15 kg^{-1}.

7. POLY4 Performance in Different Crops

Use of POLY4 had improved yields of different crops in terms of yield and quality which was given in the table 2.

Table 2: Crop improvement with POLY4 fertilization

Crops	Benefits and Improvement with the customized fertilization of POLY4
Corn	✓ POLY4 had given a consistently greater yield (+7%) than the commercial alternative (MOP+S).
	✓ Higher threshing percentage at harvesting is key to overall grain yield increase. POLY4-fertilized corn was larger which allowed the crop to capture more sunlight.
Wheat	✓ Wheat yield depends on the tillering density, ears per tiller and ear weight (grain number and weight). Wheat fertilized with POLY4 had more tillers and grains per ear than other treatments.
	✓ Application of 30 kg K_2O ha^{-1} from POLY4 gave the greatest fertilizer margin (+US$77/ha).
Chickpea	✓ There were significantly more nodules per plant when POLY4 was added instead of alternative fertilizers.
	✓ POLY4 had 38% greater chickpea yield than the standard farmer practice (N + P) and a 12% greater yield than the recommended practice (MOP+S).
Soybean	✓ A consistently superior crop performance was observed after fertilizing soybean with the POLY4 blend (+7%).
	✓ Soybean fertilized with POLY4 had adequate potassium in all years which gave enhanced nutritional balance.

Table: Continue...

Crops	Benefits and Improvement with customized fertilization of POLY4
Mustard	✓ POLY4 fertilizer plans improved oil quality, decreasing erucic acid content by 6% compared to MOP+S plans. ✓ An average 17% protein yield increase was achieved with POLY4 plans. ✓ POLY4 fertilizer plan increased crop margin by up to US$104/ha.
Cotton	✓ The treatment which has, MOP+POLY4 maintained quality producing highly uniform, long and very strong cotton fibres within the same colour grade. ✓The MOP+POLY4 treatment had the greatest fertilizer margin, which is the crop output value minus the fertilizer and spreading costs (+US$290/ha).
Sugar-cane	✓ In sugarcane POLY4's multi-nutrient supply delivered a 9% yield increase over gypsum, even at lower sulphur and calcium rates ✓ The POLY4 plan resulted in an average of 37% more potassium and significantly, 54% more magnesium than the gypsum plan in the 0–40 cm soil profile, post cropping. ✓ The POLY4 option generates an additional US$340 per hectare by applying a more appropriate balance of nutrients compared to the gypsum option.
Tea	✓ POLY4-fertilized tea had a greater proportion of high-quality, fine leaf tea and reduced susceptibility to physical damage during harvest. ✓ POLY4-fertilized tea had a greater proportion of high-quality, fine leaf tea and reduced susceptibility to physical damage during harvest. As POLY4 replaced greater proportions of MOP, residual Mg, K, Ca and S in the soil increased. Improved soil fertility may increase yields in subsequent crops in local soils that are deficient of magnesium and calcium.
Potato	✓ The tubers obtained from POLY4 treatment were also larger and therefore a greater proportion was marketable. ✓ POLY4 applied less chloride than MOP and POLY4-fertilized potatoes had 1% higher dry matter content compared to MOP+S (+20%,+13%).

Source: Anonymous, 2020a

8. Conclusion

Use of POLY4 with customized fertilization in different crops increased growth parameters, improved the nutrient uptake of K, Ca, Mg, S and improved the yield and yield attributes. POLY4 is a source of multi-nutrient fertilizer compared to other fertilizers having advantages in terms of unit cost and availability on a large scale. It is the best input for organic farming as it is obtained naturally and increases the yield in organically cultivated crops.

9. Way Forward

Though the manufacturing company of POLY4 has researched on the application of POLY4 in different crops, more Study needs to be done on the impact of POLY4 on different crops in different agro climatic zones of the India. Further there is a need to investigate the interaction between POLY4 and other essential nutrients and to understand the long term effects of application of POLY4 on soil health. Additional research should be done on use of POLY4 in organic farming and systems under different crops in different agro climatic zones of India.

10. References

Albadarin, A.B., Lewis, T.D., Walker, G.M., 2017. Granulated polyhalite fertilizer caking propensity. Powder Technology 308, 193–9.

Anonymous, 2020a. Poly4 2020. Poly4 handbook april 2020. Anglo American wood smith Ltd 2020. Available at https://www.poly4.com/site/assets/files_1/poly4 handbook_april_2020.pdf. Accessed on 20-7-2023.

Anonymous, 2020b. Poly4 product characteristics.Anglo American Wood smith Ltd2020.https://www.poly4.com/about/product-characteristics/.Accessed on 16-6-2023.

Barbier, M., Li, Y.C., Liu, G.D., He, Z.L., Mylavarapu, R., Zhang S.A., 2017. Characterizing polyhalite plant nutritional properties. Agriculture Research Technology Open Access Journal 6(3), 65–73.

Da Costa Mello, S., Pierce, F.J., Tonhati, R., Almeida, G.S., Neto, D.D., Pavuluri, K., 2018. Potato response to polyhalite as a potassium source fertilizer in Brazil: yield and quality. HortScience 53(3), 373–379.

Kemp, S.J., Smith, F.W., Wagner, D., Mounteney, I., Bell, C.P., Milne, C.J., Pottas, T.L., 2016. An

improved approach to characterize potash-bearing evaporite deposits, evidenced in North Yorkshire, United Kingdom. Economic Geology 111(3), 719–742.

Tiwari, D.D., Katiyar, N.K., Pandey, S.B., 2015. Effect of polysulphate on yield and quality of mustard and sesame in the central plain zone soils of Uttar Pradesh. Research on Crops 16(3), 493–496.

Zörba, C., Senbayram, M., Peiter, E., 2014. Potassium in agriculture-status and perspectives. Journal of Plant Physiology 171(9), 656–69.