Granite Slurry: A Valued By-Product as Fertilizer

Mohammed Azam Khan[1], Haritabh Rana[2]
[1]Manager, Business Development and Quality Control, Fastwell Dealcom Private Limited, Bengaluru, India
[2]Assistant Geologist, Geological Survey of India, Kolkata, India

Abstract: **India accounts for more than 20 % of the granite deposits of the world. Rock dust or granite slurry is a granite manufacturing waste product resulting due to the cutting and polishing process. Large quantities of rock dust are produced annually. Disposal of this rock dust has become a major problem. Granites are enriched in several alkali and alkaline earth elements such as potassium, aluminium, calcium and several trace elements. The authors have tried to find out the suitability of rock dust to its use as a fertiliser. The granite slurry is having good percentage of potassium and nitrogen with alkaline pH values which can be considered good for fertilizer use rather than keeping it as waste.**

Keywords**: Granite slurry, potassium, fertiliser, nitrogen, rock dust**

I. INTRODUCTION

Granite slurry or rock dust is a known waste product during M-Sand manufacturing. Because of the generation of large volume of slurry, the production companies pose a serious problem in disposal of this waste product.

Granites being hard and tough and its easy availability make it a household name for widespread use as a construction stone throughout the world. India is highly rich in granite which has been considered as miner mineral but it is a major contributor in foreign exchange earnings. India is the second largest exporter of unprocessed granite after China while ahead of Brazil and South Africa [1]. In India, Granite mines are spread in its different States having production shares as Karnataka (25%), Jharkhand (24%), Rajasthan (23%), Andhra Pradesh (6%), Madhya Pradesh (5%) and Orissa (5%). The granite industry of Karnataka gives a significant percentage of the national and international production leading to approximately 20 % of world’s market [2]. In the last few decades, the granite processing industry has been expanded to a large number, leading to increase in volume of granite slurry production. Disposal of these granite fines is one of the major environmental hazards [3]. Nitrogen, potassium and phosphorous are the three main plant nutrients, out of which potassium and phosphorous are exclusively sourced from geological materials [4], [5], [6].

The processing of natural stone starts from the quarry where boulders are crushed till the final product is achieved. From quarry (rocks) to final product (granite M-Sand), it involves two major processing setups, first in quarry while second in Manufacturing Unit. In quarry, controlled blasting is done using neo-gel, minor explosives and electronic detonators. Ammonia (ANFO) is also used to get the maximum yield from blast. After blasting, boulders are reduced to a size of 500 mm before feeding it to the manufacturing unit. In manufacturing unit, the raw material goes through 4 different stages. Jaw crusher reducing the size from 500 mm to 20 mm. Cone crusher reduces the size from 20 mm to 5mm. Vertical Shaft impactor (VSI) shapes the particle from angular to sub-rounded to smooth the edges by particle to particle impact in order to acquire the desired shape of the particles. Finally, the product is washed to remove the excess quantity of finer particles (below 150 microns) to make the product adhere the standards given by Bureau of Indian Standards (BIS). These removed particles (by-product) then get separated from water by using certain chemicals (Floculants) which segregates water (95% for recycling) and slurry (below 150 micron particles) from each other.

This thick slurry is then transported through pipes to a pond shaped area (with a non-porous base) where remaining water content gets evaporated. Even though after drying the powder (dried slurry) is not hazardous but its dispersal with wind may affect the environment of nearby areas, making it an area of interest for the disposal of slurry by using it in agricultural land to maximize the yield of crops. Previous studies [7], [8], [9], [10], [11], [12] have provided evidences that the granite fine particles can act as a source of nutrients to enrich the quality of soil. In this contribution, the authors have tried to find out that can slurry be used to balance the pH of soil in the nearby areas and also acting as an additive resource for macro and micro nutrients.

II .MATERIALS AND METHODS

The granite samples were collected from the mines of Makenakhalli Village, nearby Bengaluru Rural District, Karnataka, India. The Sample size ranges upto 500 mm which further goes through various crushing stages resulting into both coarse aggregate (20 mm and down, 12.5 mm and down) and fine aggregate (4.75 mm and down) material were analysed. An attempt has been made to analyse both physical and chemical characteristics of the aggregate material. The major focus of the present study lies on particle size of 150 microns and below. Electrical conductivity, pH, major element concentration, macro nutrients, micro nutrients, secondary nutrients and heavy metal concentrations of particles size below 150 micron were analysed. The authors have tried to explore the possibility of using the granite dust as fertiliser comparing it with the various crops and the amount of nutrients used by various plats.

III. RESULTS AND DISCUSSION

The granite powders analyzed in the present study presented a fine texture, containing nil clay lumps, showing that the particle size is less than 20 microns, which is very favourable in terms of the potential release of nutrients. Values of analysed parameters have been shown in Table 1. The pH values of soil sample obtained is 9.16, showing alkaline behaviour, which is mainly attributable to the composition of the powders, rich in hydroxides. The grinding process produces an increase in the surface area that favours the dissolution of cations from mineral crystalline networks which results in high pH values of the powder samples. The high pH values of the powder samples reflect the predominance of unweathered primary minerals, indicating that the mineral constituents of the powders are the main components of the granites from which they are produced, with a predominance of feldspars and quartz. The electrical conductivity was low showing a value of 0.33 dS/m, indicating a low concentration of soluble salts. Potassium shows the highest concentration of 454.44 kg per hectare, while the low concentration of calcium as 15.50 kg per hectare which depicts that the granitic composition is rich in orthoclase feldspar. Low content of calcium, phosphorus and magnesium depicts that these nutrients will have to be balanced with different sources, like lime, gypsum, and sulphur fertilizers. Potassium is an essential plant nutrient and is required in large amounts for proper growth and reproduction of plants. Potassium is considered second only to nitrogen, when it comes to nutrients needed by plants, and is commonly considered as the “quality nutrient.” It affects the plant shape, size, colour, taste and other measurements attributed to healthy produce.

Second abundant mineral after potassium is nitrogen having a concentration of 37.63 kg per hectare being considered as quality nutrients for the soil health. Partitioning of ammonia into orthoclase feldspar rather than muscovite and biotite leads to nitrogen concentrations upto 250 mg N per kg in granitic rocks (Boyd et al., 1993). Several trails of sillicate minerals on specific crops were done in past which have yielded reasonable results (See Table 2). Recommended dose of fertilizers for horticultural crops as proposed by [14], [15], [16] is shown in Table 3. The authors have tried to compare the amount of Nitrogen, potassium and phosphorous needed by several species, fruits as well as Vegetable crops provided [14], [15]; (Table 3a-c) and found that the analysed samples is having optimum values that can be used in agriculture.

Table 1: Respective values of the analysed parameters

Parameters	Soil Sample
pH(1:2.5)	9.16
Electrical Conductivity (dS/m)	0.33
Organic carbon (%)	0.08
Nitrogen (kg/ha)	37.63
Phosphorous (kg/ha)	12.641
Potassium (kg/ha)	454.44
Calcium (meq/100g)	15.40
Magnesium (meq/100g)	3.61
Sulphur (ppm)	9.10
Iron (ppm)	7.65
Manganese(ppm)	4.434
Zinc (ppm)	0.86
Copper (ppm)	0.914

Table 2: Summary of granite trails as nutrient sources

Crop	Rock	Agronomic benefits	References
Clover	Granite	Increased yield and K intake	[11]
Grass	Granite	Increased yield and K intake	[11]
Wheat	Granite	Insignificant	[17]
Wheat	Granite	Increased yield	[12]

Table 3a: Spice crops and their recommended dose of NPK (Kg per ha); Source: Ref [14], [15], [18]

Spice Crops	N	P_2O_5	K_2O
Ajwain	40	20	20
Cardamom	75	75	150
Tamarind	20	15	25
Coriander	10	40	20
Cumin	30	20	20
Ginger	37.5	50	37.5

Table 3b: Fruit crops and their recommended dose of NPK (Kg per ha); Source: Ref [14], [15], [18]

Fruit Crops	N	P_2O_5	K_2O
Banana	620	310	620
Mango	75	20	70
Litchi	50	50	25
Sapota	100	50	50
Citrus	110	35	55

Table 3c: Vegetables crops and their recommended dose of NPK (Kg per ha); Source: Ref [14], [15], [18]

Vegetable Crops	N	P_2O_5	K_2O
Sweet Potato	20	40	60
Peas	25	75	60
Okra	100	50	50
Tapioca	45	90	120

Rock dust gains momentum due to its beneficial spin-offs compared to conventional marketed fertilizer. As a multifunctional fertilizer, it is able to supply, in addition to the macronutrients (N, P and K) required for optimal crop growth, a range of other micronutrients (e.g. S, Ca, Mg, B, Cl, Cu, Mn, Mo,Zn), while it also improves the physical, chemical and biological quality of the soil. Soil quality increases as rock dust micronutrients stimulate biota and biomass. At the field level, these effects materialize in multiple profits for users, including an improved workability of the heavy clayey soils, improved water retention and water holding capacity of the soil (sandy and clay soil), increased (quality of) yields of the cultivated crops, and higher farm benefit due to decreased application and purchase cost relative to conventional fertilizers. At the local and national level, the use of locally available rock dust creates employment opportunities, increasing GDP while reducing import costs. This shift in focus leads to less greenhouse gas emissions through lower demand for conventional fertilizer. Further climate change mitigation mechanisms reside in its capacity to directly sequester carbon and indirectly stimulate tree growth, thus leaving them to act as carbon sinks. Recommended application is 2-4 tonnes/acre depending on how degraded the land is. Amending land with rock powder is a long term investment is not essential to apply every season, but once in a few years.

A movement is rising that supports the use of rock dust among small-scale coffee farmers in order to save their scarce financial resources. Tanzania has successfully tested the application of 30,000 tonnes of locally available rock phosphate on agriculture in 2008. In Asia, the large-scale use of rock dust is taking place in Sri Lanka, where 45,000 tonnes/year are consumed by tea, coconut and rubber plantations; Indonesia and Malaysia import more than 2 million tonnes per year for use in palm oil plantations; New Zealand imports 130 tonnes/year for application on vast pastures. The analysed rock powder is recommended for higher farm yields with better quality crops with improved resistance to diseases and insects. In some parts of western countries, the government is investigating the suitability of different rocks to restore grasslands.

IV CONCLUSION

The analysed rock powder can be used to manage the pH of the soil and improve the soil matrix to improve water retention and nutrients. Adding granite rock dust into the clay soil increase in the percentages of the added waste powder, the soil samples changed from having high plasticity to low plasticity and silty behaviour, which is favourable in terms of workability. It means waste natural stone powder can be used as soil stabilisers. And numerous leached trace and ultra-trace elements can be replaced with the analysed rock powder. This dust is, however, able to deliver some crop nutrients, like potassium, magnesium and calcium which can allow farmers nearby these mining sites to substantially reduce fertilizer input costs and increase yields. Nowadays, Soil health gets reduced because of over-farming, leaching and erosion. Remineralization of soil depending on the current trace and ultra-trace mineral content in the farmlands soil test results. Granite rock dust is made of volcanic rock, so it is Organic, as it’s a natural, chemically unprocessed mineral product. It is very much recommended to organic farming as it contains different elements, including many trace elements. Trace elements are often neglected by commercial fertilizers formulas, so it is a Valuable Fertilizer for organic farming. Thus, it can be said that the rock dust can be used in several agricultural aspects in India as a local solution rather than considering its disposal as a problem.

REFERENCES

[1]. Ahmad, Iqbal, Mohd Imran Khan, and Govil Patil. "Nanotoxicity of occupational dust generated in granite stone saw mill." 2011 International Conference on Nanoscience, Technology and Societal Implications. IEEE, 2011.

[2]. Lokeshwari, M., &Jagadish, K. S. (2016). Eco-friendly use of granite fines waste in building blocks. Procedia Environmental Sciences, 35, 618-623.

[3]. Allam, M. E., Bakhoum, E. S., &Garas, G. L. (2014). Re-use of granite sludge in producing green concrete. ARPN J EngApplSci, 9(12), 2731-2737.

[4]. Manning D.A.C. (1995) Introduction to Industrial Minerals, Chapman and Hall, London, 276.

[5]. Manning, D. A. (2009). Mineral sources of potassium for plant nutrition. A review. Agronomy for sustainable development, 30(2), 281-294.

[6]. Van Straaten P. (2007) Agrogeology: the use of rocks for crops, Enviroquest Ltd., Cambridge, Ontario, 440.

[7]. Gillman, G. P. (1980). The Effect of Crushed Basalt Scoria on the Cation Exchange Properties of a Highly Weathered Soil 1. Soil Science Society of America Journal, 44(3), 465-468.

[8]. Leonardos, O. H., Fyfe, W. S., &Kronberg, B. I. (1987). The use of ground rocks in laterite systems: an improvement to the use of conventional soluble fertilizers?. Chemical Geology, 60(1-4), 361-370.

[9]. Scovino, J. S., & Rowell, D. L. (1988). The use of feldspars as potassium fertilizers in the savannah of Colombia. Fertilizer research, 17(1), 71-83.

[10]. Chesworth, W., Van Straaten, P., & Semoka, J. M. R. (1989). Agrogeology in East Africa: the Tanzania-Canada project. Journal of African Earth Sciences (and the Middle East), 9(2), 357-362.

[11]. Coroneos, C., Hinsinger, P., & Gilkes, R. J. (1995). Granite powder as a source of potassium for plants: a glasshouse bioassay comparing two pasture species. Fertilizer research, 45(2), 143-152.

[12]. Hinsinger, P., Bolland, M. D. A., & Gilkes, R. J. (1995). Silicate rock powder: effect on selected chemical properties of a range of soils from Western Australia and on plant growth as assessed in a glasshouse experiment. Fertilizer research, 45(1), 69-79.

[13]. Boyd, S. R., Hall, A., & Pillinger, C. T. (1993). The measurement of δ15N in crustal rocks by static vacuum mass spectrometry: Application to the origin of the ammonium in the Cornubian batholith, southwest England. Geochimica et Cosmochimica Acta, 57(6), 1339-1347.

[14]. IIHR. 2010. Production Technology of Vegetables: A Hand Book. IIHR, Bengaluru.

[15]. IIHR. 2012. Production Technology of Tropical Fruit Crops: A Hand Book. IIHR, Bengaluru

[16]. Muvel, R., Naruka, I. S., Chundawat, R. S., Shaktawat, R. P. S., Rathore, S. S., &Verma, K. S. (2015). Production, productivity and quality of ajwain (Trachyspermumammi L. Sprague) as affected by plant geometry and fertilizer levels. International Journal of Seed Spices, 5(2), 32-37.

[17]. Bolland, M. D. A., & Baker, M. J. (2000). Powdered granite is not an effective fertilizer for clover and wheat in sandy soils from Western Australia. Nutrient Cycling in Agroecosystems, 56(1), 59-68.

[18]. Ganeshamurthy, A. N., Kalaivanan, D., Rupa, T. R., &Manjunath, B. L. (2019). An Assessment of the Fertilizer Needs of Horticultural Crops in India. Indian Journal of Fertilisers, 15(3), 286-295.